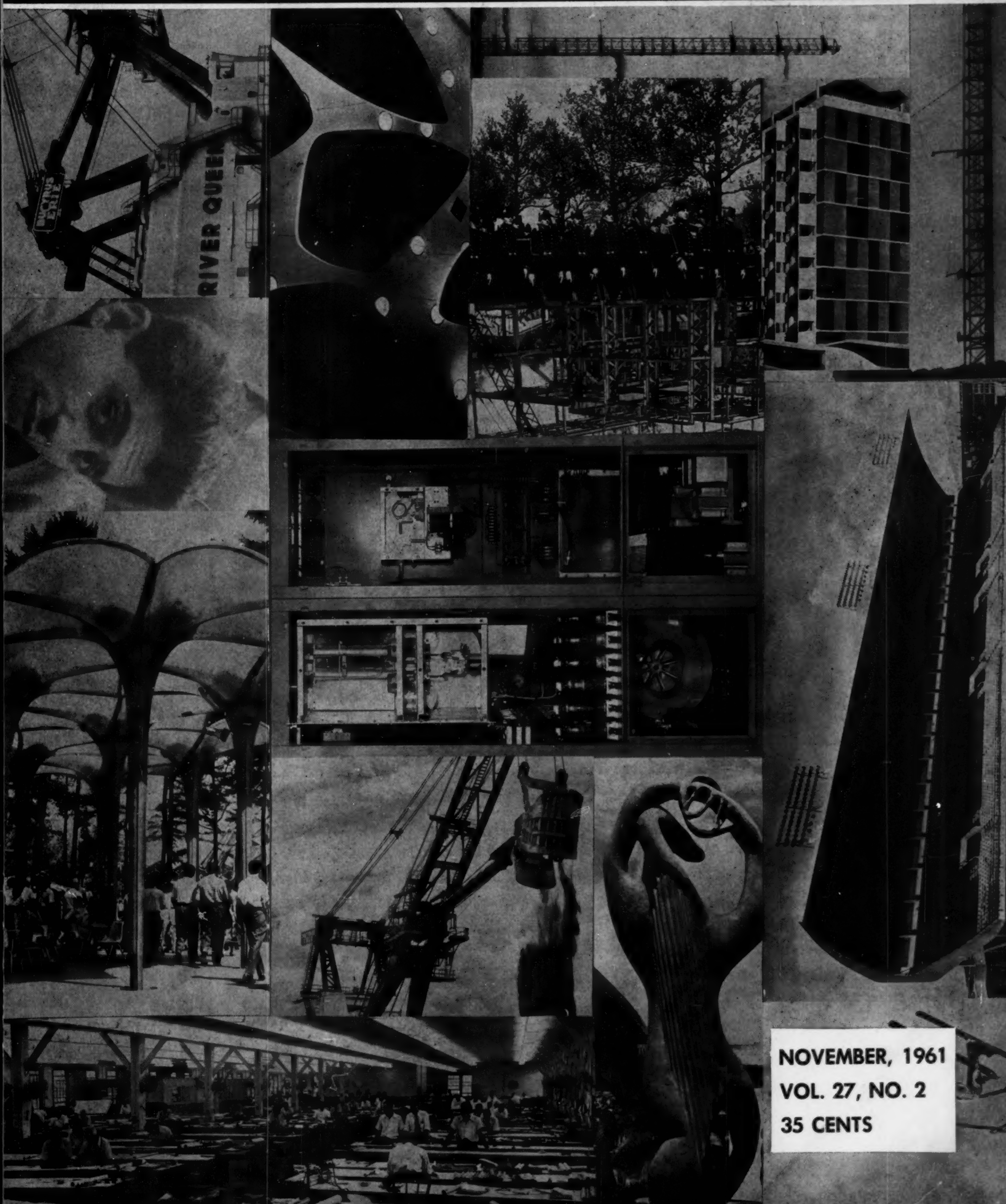
the Cornell

engineer



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THE CORNELL

engineer

NOVEMBER 1961 VOLUME 27 No. 2

FOREWORD

In recent times, science and engineering have made great progress in unlocking the mysteries of nature and in applying its principles. Continuance of this progress, and indeed continuance of civilization as we know it, depends upon the use of these discoveries and applications in constructive rather than destructive efforts. The staff of the ENGINEER, aware of the problems confronting today's world community, has prepared this issue as an examination of several aspects of the relationship between engineering and society.

COVER, by Albert Amini, Arch '62 presents varied views of the engineer and his surroundings.

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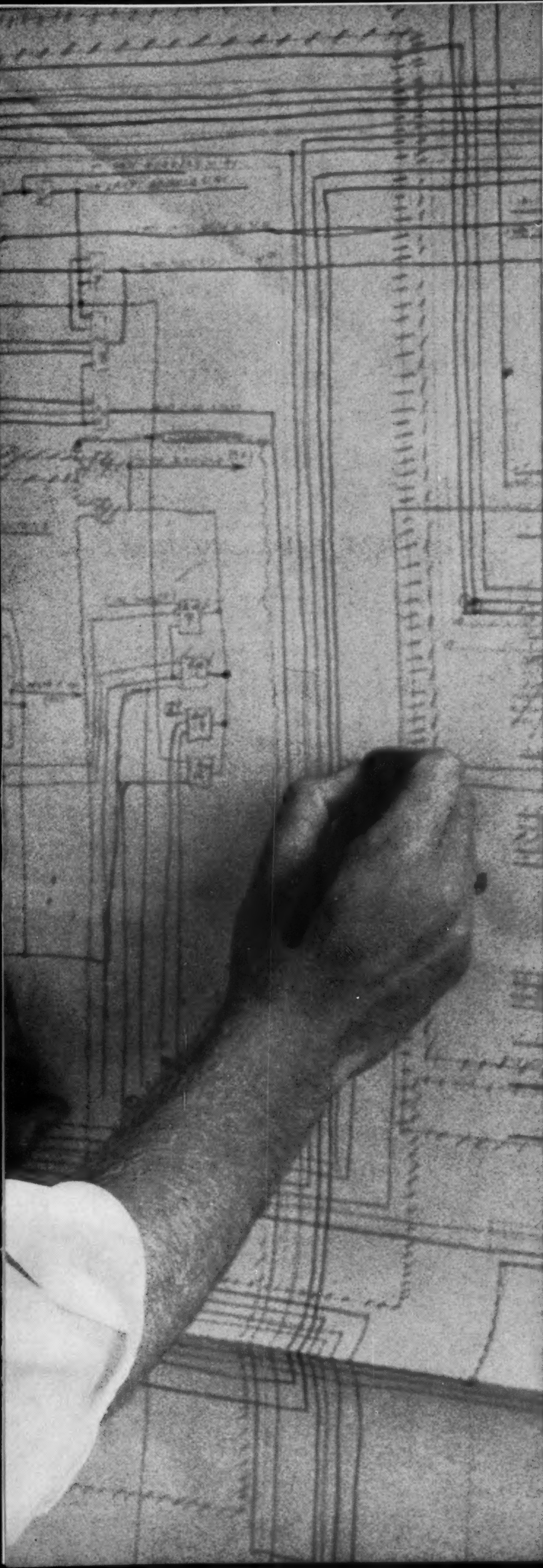

the Cornell engineer

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Specifications for A Man

"To respect my country, my profession, and myself. To be honest and fair with my fellow men as I expect them to be with me. To be a loyal citizen of the United States. To speak of it with praise and act always as a trustworthy custodian of its good name. To be a man whose name carries prestige with it wherever it goes.

"To base my expectations of a reward on a solid foundation of service rendered. To be willing to pay the price of success in honest effort. To look upon my work as an opportunity to be seized with joy and to be made the most of, not as a painful drudgery to be reluctantly endured.

"To remember that success lies within my own self and in my own brain, my own ambition and my own courage and determination. To expect difficulties and force my way through them. To turn hard experience into capital for future struggles.

"To believe in my profession heart and soul. To carry an air of optimism in the presence of those I meet. To dispel all temper with cheerfulness, kill doubts with strong conviction, and reduce action with an agreeable personality.

"To make a study of my business. To know my profession in every detail. To mix brains with effort and system in my work. To find time to do every needful thing by not letting time find me doing nothing. To hoard days as a miser does dollars. To make every hour bring me dividends in increased knowledge and healthful recreation. To keep my future unencumbered with debts. To save as well as to earn.

"To cut out expensive amusements until I can afford them. To steer clear of dissipation and guard my health of body and peace of mind as a most precious stock in trade.

"Finally to take a good grip on the joys of life. To play the game like a man. To fight against nothing as hard as my own weakness and endeavor to give it strength. To be a gentleman and a Christian so I may be courteous to man, faithful to friends, and true to God."

Found among the papers of Thomas J. Van Alstyne, former electrical engineering student, Cornell University, after his death on the job.—Cornell Civil Engineer, 1915
Vol. 23, p. 154

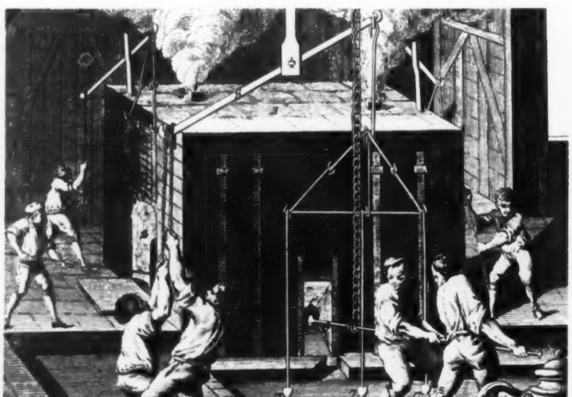
IS ENGINEERING PROFICIENCY SUFFICIENT?

The impact of technological developments of the twentieth century on our society is unmistakable. Through scientific discovery and engineering application of natural law, men have suddenly achieved power almost beyond comprehension for the control of environment, the spanning of space, and the shaping of the world's resources for the benefit of society. Rather than winning acclaim for the imposing list of achievements which have brought improved health and better food, greater comfort and safety, and faster communication, the technological community stands at the bar of world opinion accused of creating, instead, the means of society's destruction. Surely the most penetrating example of widening divergence between technological advance and sociological adjustment is in the field of modern physics, where understanding of the principles of fission and fusion processes has led to developments feared because of destructive potential rather than respected for the ultimate good which society can realize from their proper exploitation. As Dr. Simon Ramo has recently said, "There is already a gross imbalance between technological and sociological progress."

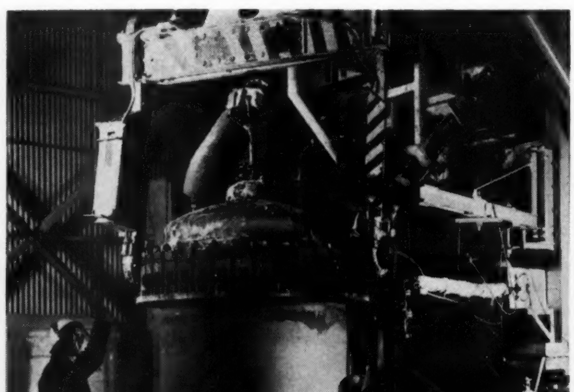
The course of history indicates that technological advance can not be prevented. Should the present store of nuclear weapons be suddenly neutralized, it is probable that a new, perhaps more deadly, weapon would soon be conceived. The challenge to men today is not to stay technological development, but to speed moral and social progress so that the output of the laboratory can be assimilated for man's benefit.

It is probable that countermeasures developed through science and engineering have not yet become sufficiently sophisticated to insure that civilization will be pro-

Modern scientific advances have created . . . The means for advancement . . . .

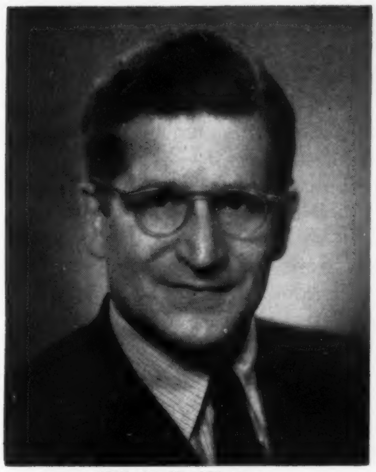


Rapid engineering progress of the past two hundred years has made possible mass production of goods and has created today's highly specialized society. Here, a typical factory of



French Revolutionary times is compared with a modern chemical plant. Introduction of machines has removed the burden of heavy physical labor from the modern worker's shoulders.

by Edwin B. Watson



Edwin B. Watson

ABOUT THE AUTHOR

Edwin B. Watson, former professor of Mechanical Engineering at Cornell, is now chief engineer of the diesel injection department of Bendix Aviation Corporation, Sidney, New York. Mr. Watson joined the Cornell faculty in 1943 and became an associate professor in the Department of Thermal Engineering in 1947. A long-time associate of the *Cornell Engineer,* he served on its advisory board for more than two years. While at Cornell, he also advised Tau Beta Pi and Pi Tau Sigma. Mr. Watson accepted his present post in 1959. He is a member of Phi Beta Kappa, Tau Beta Pi, Pi Tau Sigma, Society of Automotive Engineers, and ASME.

tected against today's deadly threat to its existence. A recent statement by a renowned scientist suggested that nuclear warfare, if unleashed, might be expected to devastate vast areas of the world in as few as two days. Optimism must prevail that the present international tensions will be relaxed as a consequence of deliberations of statesmen and politicians who, regardless of ideological beliefs, are cognizant of the holocaust that would ensue if negotiation fails; and that time, therefore, will be gained for society to progress in its attempt to adjust to the impact of twentieth century military technology.

What indications are there that society is progressing in the sociological adjustment to technological advances? There are promising signs that international cooperation can be stimulated through the means of science and engineering. The success of the recent IGY program and its current extensions, including the Antarctic Research Program, the Indian Ocean Survey, and other projects, has demonstrated that political differences and nationalistic pride can be subjugated to the internationalism of scientific discovery. One of the organizers of the International Geophysical Year, Hugh Odishaw, in a recent article in the prototype issue of *International Science and Technology,* has said, ". . . scientists have an urgently important role to play in the conduct of international enterprises. And nowadays, they have, and can use, enormous power to affect governments.

"If they are to use this latent power, scientists have to consider carefully their responsibility to mankind, for it is tempting in

or for destruction . . . Now . . .

United Press International

The destructive forces that scientific advances have unleashed created this scene of devastation in Hiroshima after the atomic holocaust during World War II. The problem facing scientists: for what purpose will our discoveries and inventions, intended for man's benefit, be used?

troubled times to stay within the laboratory. . ."

The increasing internationalism of commerce and industry will eventually erase barriers to understandings between peoples of the world. The language of engineering is, in a real sense, international. Despite differences in techniques or practice, a blueprint rendered in a design room in Detroit, Chicago, or Los Angeles can be understood in London, Paris, or Madrid.

As living standards in the emergent nations of the world rise due to the inevitable technological advances, it can be hoped that strong nationalistic fervor will develop into more sophisticated world citizenship, thereby relieving some of the causes of present international stress. As populations of the world are better fed and clothed, and develop the means through technical advance for improving the economic base, tensions may be relaxed.

Scientists and engineers in government, industry, and education, will be called upon to consider more frequently, and in greater depth, the political, economic, and moral consequences of their work. This suggests that for the individual, as for society as a whole, technological proficiency is not enough. To play his full role in solving the pressing problems of our time, the technologist must be educated in areas other than his technological discipline.

The young engineer sent suddenly to Europe, Asia or, perhaps, South America to advise on the erection of a new plant, the installation of a new machine, or the development of a new product or process is more than an engineer —he becomes a spokesman for American industry and, to some degree, a representative of the American way of life. The success of his mission will depend not alone upon his technical proficiency, but on his ability to earn the respect of foreign associates. An obvious barrier to mutual understanding is the language difference. Failure of American engineers abroad to be knowledgeable about local customs and business methods, or perhaps more harmful, failure to be tolerant, has doomed many a mission. The increasing role of the engineer in international commerce has suddenly focused attention on the practical need for young engineers to be better prepared for foreign assignments. While specific training for such a mission is helpful, it seems certain that greater success will be attained when more emphasis is given in our secondary school curricula and in engineering curricula to the spoken foreign language, economic geography, geopolitics, and the economics of world trade, so that, through his entire educational program, the young engineer is being prepared for his broadening role in industry.

It must be admitted, parenthetically, that our foreign friends generally have far more knowledge of the United States, its government, its history, and its economic system, than we have of theirs. This is perhaps understandable, but in view of the problems of our times, regrettable. How much more effective is the conduct of business when all parties have a common understanding of the subtleties of the problem, and negotiations can proceed in a single tongue!

The same attributes will be required of the scientist who stands apart from the call of commerce to engage in research. More frequent interchanges of research people between nations of the world requires that the language deficiencies, particularly peculiar

Scientists and engineers must prepare for an active role

The technological societies of the world have made great progress toward an acceptable standard of living for all. In less progressive lands, however, agriculture is still carried on by primitive methods, people perform heavy labor, famines occur. The spread of technical knowledge and equipment will help alleviate such conditions.

Cornell Countryman

to Americans, be swept away, and that scientists of all nationalities be more knowledgeable about the history, customs, and social-political motivations of their foreign associates.

For the engineer oriented toward management, the challenge is perhaps the greatest, since American industry is becoming international at an accelerated rate. No longer can decisions be based only on national conditions, but the influence, or effect, of the international market must be assessed.

Granted that the engineer will play an increasingly important role in world affairs as a consequence of the rapid growth of internationalism in commerce, industry, and science, what can be said of his function in our domestic society? As a consequence of his work, our society has achieved a material well-being considered impossible a few generations ago. About to cross the technological threshold are new discoveries which may enable man to control weather, will improve his ability to communicate, will enable the time of travel from east to west to be measured in minutes, and will free the minds of men for creative endeavor rather than routine calculation or clerical effort better performed by electronic devices. To this list can be appended other potential developments, some in infancy, some in advanced stages, but all of which will tend to advance the technological character of our society. Is society ready to assimilate these developments? Have those who manage or administer our industrial complexes, our governments, our educational institutions, developed blueprints for action in meeting the problems these pose?

Consider the problem of technological unemployment. Only recently have the combined efforts of business, labor, government, and public-spirited foundations been brought to bear on defining the magnitude of the problem and the probable course of its future growth. Only token solutions have been proposed. Increased mechanization of the productive facilities, as well as the administrative functions of industry, government, and commercial institutions, is inevitable, and ultimately, as history proves, the result will be additional leisure and higher income for American society. What, however, is the proper action in the interim period to absorb the impact of temporary dislocations to the economic well-being of some of our citizens?

What about the problem of foreign competition in our domestic market? Have we delineated the boundaries of the problem and determined its full impact upon our national economic life? Based upon available evidence, it would appear that no national policy has been developed to deal with this complex problem. Some farsighted corporations have taken steps to mitigate the effects of imports and to maximize their ability to be competitive in the world market. Have engineers, as concerned citizens, made their voices heard in Washington during deliberations on proposed national policies of taxation that might assist industry to become more competitive by stimulating replacement of obsolete facilities? Have we, as design engineers, thoroughly appraised our product intended for overseas sale, to determine, in the light of the potential buyer's need, whether it is properly designed?—Or are we content to assume that his need is the same as ours? The outstanding trait that has characterized American industry has been its productive genius.—Have we, without prejudice, appraised foreign technological progress in the field of production?

in solving the problems of this era.

Today's problems include fostering the spirit of international cooperation so that all may have a better life. Below, students of city planning confer over a project model. At right, Gregory Okafor, Grad., and Barry Marrus, CE '61 test a sample of Nigerian soil.

Photo Science

C. Hadley Smith

It is the essence of engineering that decisions and actions will be based on fact. Every facet of the education of the engineer compels him to search for factual data which are reproducible and which form the true basis for an engineering solution. As a class, engineers prefer, by training and temperament, an absolute answer based on sound data. Conversely, the engineer generally shuns decision based on hunch, personal prejudice, wishful thinking, or influenced by social or political consequence. In an era where sound decisions reached by reasonable men and based on the most factual data available are so urgently required if pressing problems are to be solved, the peculiar training of the engineer should fit him for an increasingly important role in decision-making. Unfortunately, this respect for factual decision, so frequently impossible in situations where other compelling interests are at stake, has caused the engineer and scientist to avoid participation in public affairs, and his counsel is lost. It is time that the members of the technological community of scientists and engineers are heard when decisions relative to problems resulting from their efforts are being made.

If the scientific community is to be heard with respect, it must, as Dr. Odishaw has said, "... consider carefully its responsibility to mankind ..." Engineers must become more articulate, and judgments must be based upon a full appreciation of man's total universe. The first obligation of the engineer is technical competence, but for personal success and full effectiveness as a citizen and as a potential manager, more is required. It would be desirable for all engineering students to study, at every opportunity, in fields other than science or engineering, to cultivate an apreciation for the non-technical implications of technical matters, and to develop an attitude which recognizes that all decisions can not be based on well-documented fact.

A start on such a program can be made by undergraduate students through the judicious selection of elective courses in areas of the University other than engineering. In pursuing such courses as economics, government, history, and the multitude of others available in a university such as Cornell, these should be regarded not as a requirement to be met, but as an opportunity for personal enrichment in areas of vital importance in a student's total education.

No matter the extent of an engineering curriculum, it will not be possible for the interested student to obtain a full measure of technical proficiency and general education. The mark of an educated man, after all, is his ability to learn for and by himself. The young engineer will improve his opportunity for advancement and success through a planned program of personal development. By all means, let this program include a variety of readings in fields other than engineering.

Is technical proficiency sufficient? Neither in the development of society nor in the development of the individual engineer is it a sufficient condition for success. Having created the means for either civilization's destruction or its continued advancement to new levels of comfort and security, is it not proper and urgent that engineers and scientists prepare for a more active role in society's effort to develop solutions to the first order problems of this technological era?

ENGINEERS' CREED

As a Professional Engineer, I dedicate my professional knowledge and skill to the advancement and betterment of human welfare.

I pledge:

To give the utmost of performance;

To participate in none but honest enterprise;

To live and work according to the laws of man and the highest standards of professional conduct;

To place service before profit, the honor and standing of the profession before personal advantage, and the public welfare above all other considerations.

In humility and with need for Divine Guidance, I make this pledge.

Adopted by
National Society of Professional Engineers
June, 1954

Why college men choose careers with Du Pont

Every year, several hundred new college graduates choose Du Pont. Many Masters and Ph.D.'s do, too.

Recently we asked some of them what factors influenced them to decide for Du Pont. They cited more than half a dozen reasons. Here are some they almost all agreed upon:

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They were aware that college-trained beginners go right to work with men who have achieved. For example, research chemists work with individuals who've done successful research. New engineers work with pros, some of whom have designed new plants, or devised new manufacturing methods, or distinguished themselves in some other way. And other graduates, with B.A. or M.B.A. degrees, go to work with leaders who've been successful in Sales or Advertising or Treasurer's, or another of Du Pont's many departments.

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Men like working for a company that believes in research, enough to invest in it . . . $90 million a year! The fact is that important new products come from Du Pont laboratories and go to Du Pont manufacturing plants with frequency.

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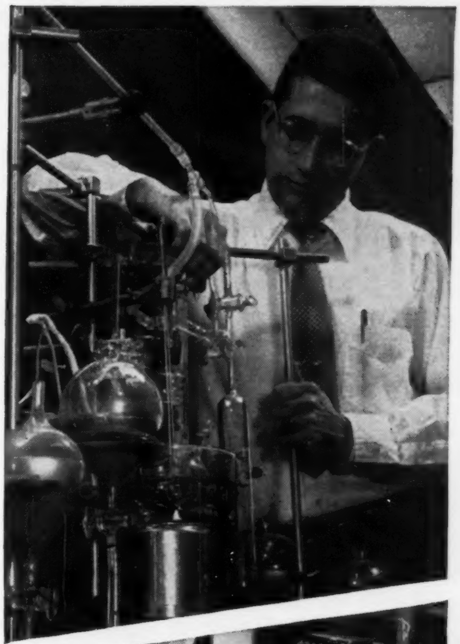
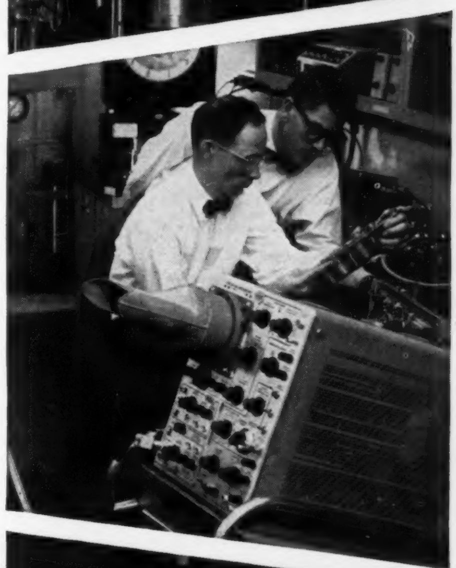
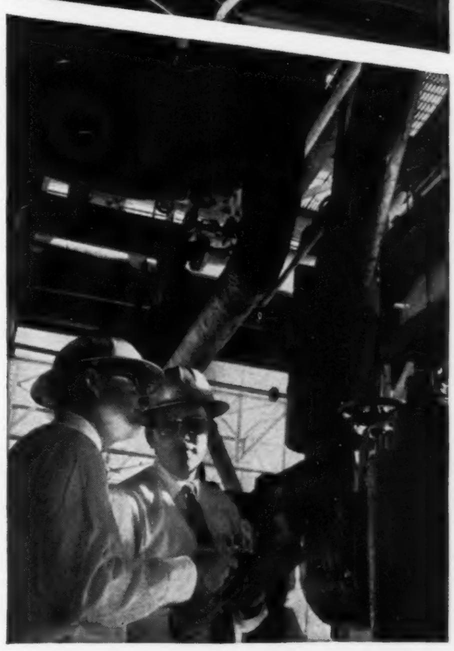






PROFESSIONALISM

by Prof. John C. Gebhard

Professionalism means "conduct, aims, quality, etc., characteristic of, or peculiar to, a profession or professional men; specifically, professional solidarity."[1]

Engineering is a profession which has many facets. By the time a young man has received his engineering degree, he has acquired a rather clear concept of the scientific and technical aspects of his chosen field. The chances are, however, that he has only a hazy notion of the less orderly non-technical phases of his profession. When he graduates he rightfully thinks of himself as a member of the profession, even though he may not legally call himself a professional engineer until he has gained the necessary experience and has been formally licensed by a state. But does he know what being a professional man implies? Does he make an effort to find out? And having found out, is he willing to assume his professional responsibilities and guide his development accordingly? Probably three out of four engineers work in "industry"—for salaries rather than fees—in complex production-minded organizations. Is it possible for them to grow in stature as professionals under "factory" conditions, or will their attitudes become those of their union-minded fellow employees who work at arms-length for, rather than with, management? Some observers say that we are entering an era in which the engineering profession needs to concentrate less on developing powerful new technical tools and more on finding ways to synthesize social, economic, and political factors into their equations. "Engineers who know nothing of the import of their work on society and care less are a menace."[2] They must deal with reality in all its aspects and should assume their professional responsibilities. It is appropriate therefore that engineers take time to inform themselves in matters like these and that they develop a personal philosophy regarding them which will guide their professional conduct.

First, it is desirable to have a good notion of what a profession is. The image which many persons have drawn from their views of the "three learned professions"—law, medicine, and theology (so called because they were taught in universities)—does not adequately portray the situation today. Many other vocations have acquired professional status and many more are striving constantly to reach this social recognition. Some, like engineering, have become industrialized to the extent that a significant number of practitioners no longer have the intimate personal doctor-patient relationships that are commonly associated with professional men. Currently the U.S. Bureau of the Census recognizes about 23 broad occupational groups as professions. In 1960 they included about 3.8 million persons, or about 6.4% of the labor force. Technical engineers formed the second largest group, following teachers, with 534,000 members. Nurses, accountants, physicians and surgeons, lawyers and judges, and clergymen followed in that order. The 1960 census will no doubt, show increases in all these figures, but the ranking of the groups is probably the same.

"The professions are the occupations through which people obtain the highly specialized intellectual services. Taken together, they constitute the smallest of the broad occupational groups in the Nation as recognized by the U.S. Bureau of the Census. However, in spite of the relatively small number of persons engaged in these services, the day-to-day functioning of the communities and the Nation depends largely on them. Without them civilized society could not be maintained on the present basis."[3] There are many other definitions. All emphasize such distinguishing characteristics as (a) "special knowledge, not purely commercial, mechanical, etc., . . . used by way either of instructing, guiding, or advising others, or of serving them in some art;"[4] (b) "mental rather than manual labor; . . . special discipline."[5] (c) "relatively long and special preparation on the higher level of education and governed by a special code of ethics."[6] (d) "concern with theoretical or practical aspects of complex fields of human endeavor."[7] (e) "advisory, administrative, or research work which is based on the established principles of a profession or science."[8]

Probably the most distinguishing characteristic is the need for special study and training or "the possession of a body of knowledge, a set of attitudes, and a group of skills, collectively called a technique, which enables the members to perform a particular type of service. The course of education

and training is a combination of theory and practice which is enforced through a series of educational requirements and in many instances an examination system."[3] In the case of engineering, college curricula are accredited by the Engineering Council for Professional Development, which is composed of members of the principal engineering societies.

Another earmark of a profession is that success is measured by "accomplishment in serving the needs of people" rather than by financial standards. The professional is devoted to his art and derives his prime satisfaction from doing a good job and gaining the esteem of his fellow professionals.

A third characteristic of a profession is that its members band together in exclusive organizations to "talk shop", advance knowledge in their field, assist young men to grow in the profession, and to act collectively in other ways to further the interests of their profession and to better serve the public. Because many of these societies restrict membership to persons having certain minimum qualifications, members acquire a badge of recognition of professional standing that is helpful to themselves and to the public. The engineer who does not support his professional society not only fails to take advantage of an excellent opportunity to benefit himself personally in many ways, but he also shirks a professional duty. In engineering, the problem of deciding which societies to join may be quite perplexing. There are hundreds of them, ranging from small purely technical groups to social organizations and unions concerned only with wages, working conditions and job security. Unlike the American Bar Association and the American Medical Association there is no one society the engineer can join that can speak for the engineering profession as a whole with comparable authority. However, unity is provided by the Engineers' Joint Council. This is a federation of engineering societies (23 at present) which coordinates the activities that are of common interest to the various branches of the engineering profession particularly at the national and international levels. Progress to greater unity will, no doubt, speed up when the headquarters of many societies are brought together under one roof this fall in the new 20-story United Engineering Center in United Nations Plaza in New York. The National Society of Professional Engineers is also devoted to the problem of promoting greater unity among all members of the profession. It is concerned primarily with the non-technical interests of the engineer and requires registration (licensing) as a Professional Engineer as a condition of membership.

Professional societies in the United States have developed codes of ethics much more extensively than in any other country. This is one of the more unique characteristics of the professions. These codes set forth in writing a set of principles, ideals, and regulations to guide and control the conduct of their members. Some states go so far as to require registrants to subscribe to a code of ethics before they are licensed as Professional Engineers. Violations of these codes can result in expulsion from the society or loss of license which can, of course, result in loss of prestige and business. It behooves an engineer to study his code and to apply its principles in guiding his conduct and way of life. The "master" code for all U.S. engineers is "Canons of Ethics for Engineers," adopted by the Engineers' Council for Professional Development in 1947. Like most codes it has sections dealing with professional life, relations with the public, relations with clients and employers, and relations with other engineers. Each member of a profession has an interest in the standards observed by his fellows. An act which causes the public to lose confidence in one engineer is damaging to the profession as a whole. When engineers deal directly with people as consultants, ethical matters are usually easier to resolve than when they operate through a corporation or government agencies. Should this make a difference in an engineer's conduct? Currently, the ethics committees of the American Society for Engineering Education and the Engineers Council for Professional Development have joined forces in stimulating new interest in professional ethics, prompted in part by the waves of "payola" and other scandals that have spread across the nation in recent years. Among other things, these groups are preparing a "Case Book on Problems in Professional Ethics" for engineers for use by educators, students and the profession in general. This will probably be the first of its kind and should serve to move the matter of ethics from the atmosphere of the Sunday morning pulpit to the desks and job-sites of

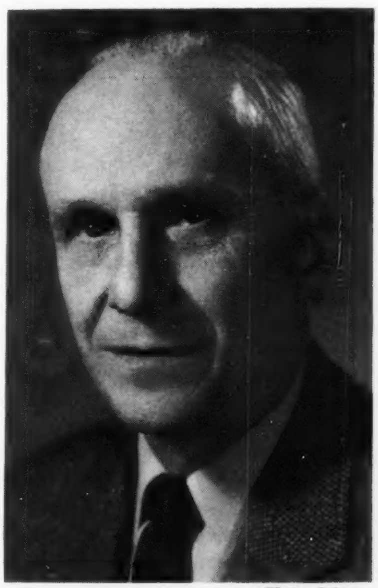


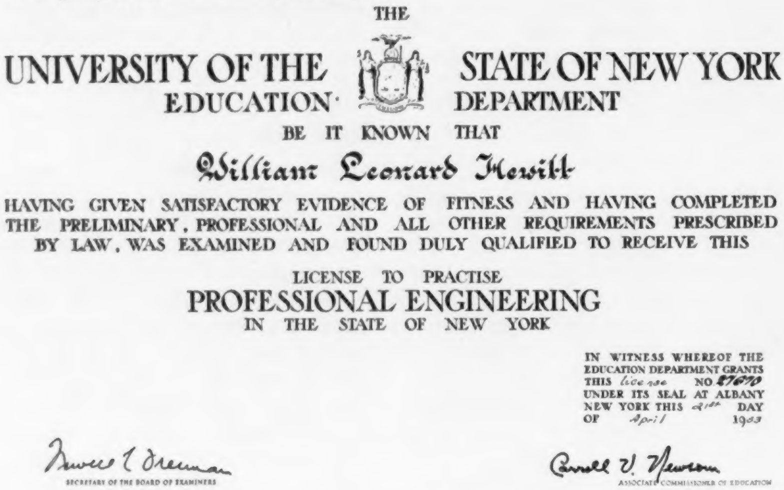
Photo Science

Professor John C. Gebhard

ABOUT THE AUTHOR

Professor J. C. Gebhard received his Civil Engineers degree from Cornell University in 1919. He is presently the head of the Department of Construction Engineering and Administration in Cornell's C.E. School and chairman of the School's Ad Hoc Curriculum Review Committee. Professor Gebhard is also a member of the Associated General Contractors of America—American Society on Engineering Education, (AGC-ASEE), a joint cooperative committee concerned with education for the construction industry.

The professional is characterized . . .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BE IT KNOWN THAT

William Leonard Hewitt

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PROFESSIONAL ENGINEERING
IN THE STATE OF NEW YORK

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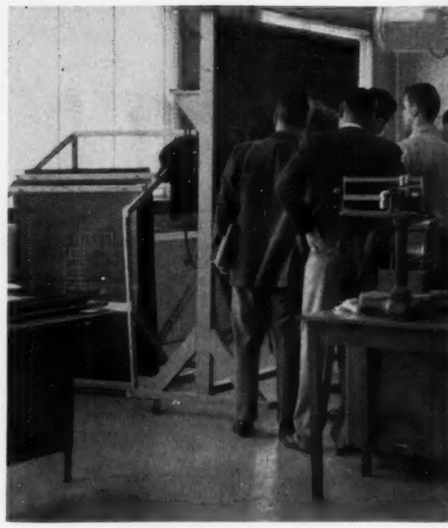
SECRETARY OF THE BOARD OF EXAMINERS

Carroll V. Newsom
ASSOCIATE COMMISSIONER OF EDUCATION

Courtesy of Prof. W. Hewitt

by official recognition . . .

Every state in the nation now has a professional engineer's licensing law. Requirements may include a college degree, a number of years in engineering practice, and successful performance in an examination.

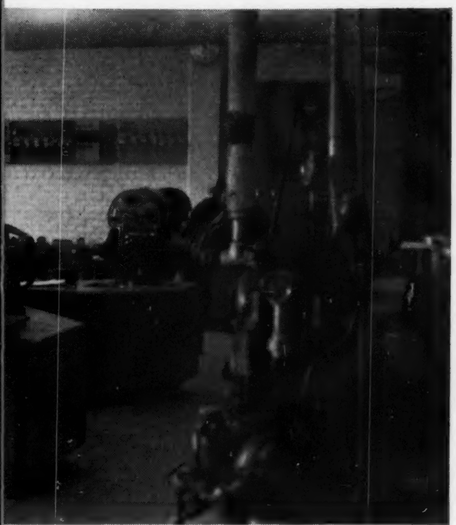


by education . . .

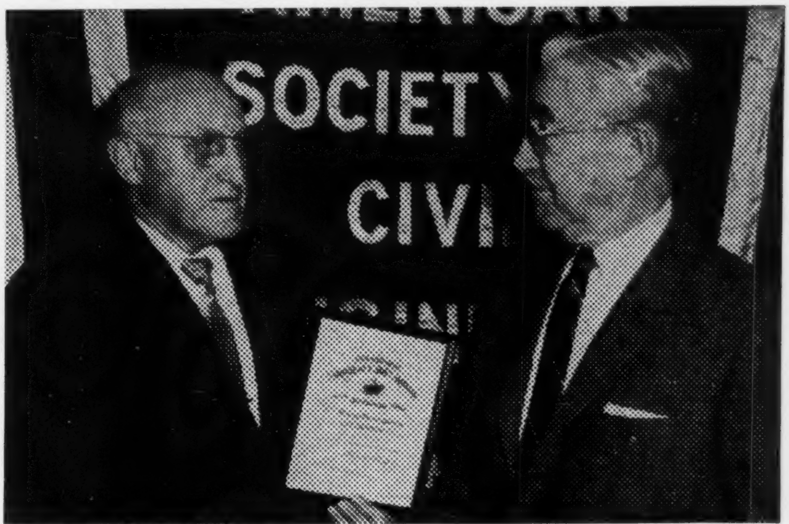
The professional, be he doctor, lawyer or engineer, has studied to acquire a highly specialized body of knowledge. A

engineers. Not all ethical questions are black and white. Many fall in the twilight zone where honest differences of opinion exist and where rather fine distinctions must be drawn. May an engineer advertise and how loudly may he blow his horn? May he bid in competition for a job? May he criticize or review the work of another engineer? May he specify a proprietary product? May he accept an assignment, knowing that the services of another engineer for the same project were terminated? May an engineer in industry perform free engineering services for a prospective buyer of a product? May he accept gifts from contractors? What information may an engineer carry from one employer to another? May he express his opinions to potential clients regarding the capabilities and shortcomings of other engineers? What can he do if his company advertises extravagant claims for a product which he has designed? May he collect full travel expenses from three organizations which he interviewed for a job in the same city during the same trip? If a supervisor does not agree fully with the recommendations of one of his engineers may he direct him to change them, and should the engineer do so? These and many other situations make interesting brain-teasers, the solutions to which can affect an engineer's career and the reputation of his profession.

Another matter of professional concern is licensure, or registration. In medicine and law all qualified members, regardless of field of employment, are licensed. In engineering, however, only those who are in a position to make responsible decisions affecting safety, health, property, and rights, are required by law to be licensed. This is an exercise of the police power of the states and is not to be confused with licensing to engage in business. Each state and territory now has an engineer registration law. There is no national registration. At present about 250,000 engineers are registered. While this is less than half of the engineers in the U.S., the marked increase in registrations in recent years indicates a growing interest in this procedure, not only on the part of engineers, but also by industry and government. No engineers in the Federal government, and very few engineers in industry, are required by law to be registered. Why, then, go to the trouble and expense to obtain a license? This, for most engineers, is a subjective decision. The arguments for seem to outweigh those against. From the point of view of the profession, registration is a legal recognition of engineering as a profession. It is a mark of prestige and the layman's assurance that the holder can be entrusted with engineering work. It promotes solidarity among the profession, and helps to control competition by incompetents. From the point of view of employers of engineers, it helps them in selecting and promoting qualified men and in building up a professional esprit in their organizations. To an increasing degree, states and local governments are requiring that engineers, especially in the higher positions, be registered as a condition precedent to promotion. Likewise, industry is recognizing the subtle value of registration and is, more and more, encouraging its engineers to obtain licenses. It will not be surprising if, one day, all engineers are required to be licensed, regardless of field of employment, the same as lawyers and doctors. The procedure for registration varies from state to state. For new graduates, the simplest procedure is to take a written examination as soon as possible after graduation and obtain a certificate identifying them as Engineer-in-Training. After they have had the necessary practical experience, usually four years, they are required to pass a further written and/or oral examination before they are eligible to call themselves Professional Engineers and to affix "P.E." after their names. It is illegal to use the word Engineer or Professional Engineer in ways which lead others to believe the user is a registered engineer. Courts often hold that a person may not collect on a contract for engineering services unless he is registered. Also,



group of mechanical engineering students are shown receiving instruction before performing a laboratory experiment.



by cooperative activity.

Civil Engineering

The professional engineering societies provide a medium for the exchange of information and ideas among engineers. The societies recognize outstanding professional achievement and encourage young people to enter the profession. Above, a distinguished engineer is presented with a life membership in ASCE.

some courts hold that a person may not testify as an expert witness unless he holds a license. In short, the wave of the future seems to point to a greater unification of the engineering profession through the device of registration.

And, finally, there is the matter of civic duty. One authority put it this way, ". . . one of the greatest causes of the sickness of society is the aversion of its natural leaders, among whom I include its professional men, to perform their obvious duties as citizens."[9] Engineers share this guilt. Society expects them, above all else, to be competent technically, and by temperament this is their major interest. The result is that they, like men in other professions, become so absorbed in their technical worlds and family life that they lose concern for public affairs. Yet society looks to the professions for advice, assistance, and leadership in local, state, and national affairs. They were drawn from the intellectually more capable strata of society and were educated partly at government expense. Do they not, therefore, owe society more than strictly technical contributions? May not the engineer counter by saying that public affairs should be handled by professionals, even as engineering is handled by engineers? But how far could this stratification be carried before the base of our democratic form of government is destroyed? Not far! This is one "profession" in which all must take part, and the engineer must make time to do his share.

These, then, are some of the facets of professionalism: a college degree; continued study; a nonstandardized flavor of work; a strong sense of responsibility and public service; dedication to one's art; desire for achievement above financial gain; a feeling of comradeship and solidarity among members of the group; association of practitioners into societies that set professional standards, stimulate the growth of their members, and promote service to the economy; self-imposed, and enforced, codes of ethical conduct; licensing by the state to insure protection of the public; a sense of belonging to the management team; and constructive participation in civic affairs.

Engineers, particularly those in industry and government, need not despair of achieving professional status under "factory" conditions if they will act as professionals and, in concert, continue their efforts (which have already begun to bear fruit) to educate management in the facts of professional life. This approach has, for example, worked at Quaker Oats, whose Chief Engineer has said, "Our engineers feel they are treated as professional people who are responsible for important work and who are at the same time enlarging their experience. This builds an organization of thinking people. We are captive consultants. We are paid to help management and we feel we have a professional responsibility to help and protect them. There is no engineering for engineering's sake. We are paid to do a job."[10]

As one member of the Engineers Joint Council has said, "Engineers have the choice of becoming a strong profession or a heterogeneous and disorganized mass of technical workers."[11] Will coming generations rise to the challenge?

FOOTNOTES

1. *Webster's New International Dictionary.*
2. Melvin Nord in *Legal Problems in Engineering.*
3. "Education for the Professions," U.S. Department of Health, Education and Welfare 1955.
4. *Webster's New International Dictionary.*
5. Funk and Wagnall's *New Standard Dictionary of the English Language.*
6. *Dictionary of Education,* Good.
7. *Dictionary of Occupational Titles,* U.S. Government Printing Office.
8. U.S. Bureau of the Census, "Classified Index of Occupations."
9. Arthur T. Vanderbilt, Chief Justice, Supreme Court of the State of New Jersey.
10. "Professionalism at Quaker Oats," *American Engineer,* July 1961.
11. Dean E. C. Easton, College of Engineering, Rutgers University, in *Engineer,* Summer 1961.

THE CHANGING WORLD OF ENGINEERING THROUGH HISTORY

by S. C. Hollister

Emeritus Professor of Civil Engineering

In the ancient cultures the engineer emerged along with the architect as the master builder. He was not only skilled in the crafts appropriate to his work; he was also learned in the practices appropriate to the fitness of his construction. He was one who knew how to contrive, to plan and to construct. He possessed the necessary ingenuity.

The early works of the engineer were largely civil works, such as roads, bridges, aqueducts and harbor works. Engineers understood the principle of the lever and the pulley, the wedge and the screw, but could not foretell the strength of a beam or column. Suitability for strength and deflection was the result of previous trial and error passed down from one to another. The surviving examples of their work, of course, were only the successful ones. We do not know how many trials that were unsuccessful lay behind each of these successful designs. Considering their restricted background knowledge, their designs showed great ingenuity and daring.

The ancient engineers had no power of mathematical analysis. Their mathematics was limited to arithmetic and geometry. The early Romans undoubtedly sensed the mechanical action of the arch, although its analysis was not available until the 19th Century. The principle of the arch was extended to contrive the dome, one of the finest Roman examples of which is in the Pantheon in Rome. Again, the theory underlying the behavior of a dome was not available until the last century.

A student in the university of the 12th Century would certainly not find a course in engineering. Such preparation as then existed was combined in the seven liberal arts. These were divided into the trivium and the quadrivium, the latter being the more advanced division and taken only after completion of the trivium. The trivium consisted of grammar, rhetoric and logic, whereas the quadrivium consisted of arithmetic, geometry, astronomy and music. In passing,

Emeritus Professor S. C. Hollister

ABOUT THE AUTHOR

Professor Emeritus Solomon C. Hollister retired as Dean of the College of Engineering in 1959, after serving in that post for more than twenty-two years. He was previously Director of Cornell's School of Civil Engineering. Professor Hollister's years as Dean of the College saw the institution of the five-year engineering program and the building of most of the new engineering quad. His outstanding achievements as an educator parallel his outstanding accomplishments in engineering practice, among them consultant work on the Hoover Dam penstocks and studies for enlarging and modernizing the Panama Canal. At left Professor Hollister is shown with his collection of rare and historical books, from which this article's illustrations were taken.

it should be noted that some modern humanists and social scientists have scaled down the concept of the liberal arts well below what it should be, since they have omitted from their concept a knowledge of the sciences that were originally included in the seven liberal arts. In terms of the early university programs, they would settle for the trivium only, or only three of the seven liberal arts.

There was little change in the manner in which the engineer practiced until the advent of modern analysis in mathematics together with a more precise knowledge of the behavior of materials. The ability to write algebraic equations through the use of symbols emerged in the 16th Century. Prior to that time, mathematics was an abstract, philosophical exercise. It was, in fact, a philosopher who brought forth the first writing in the calculus. This was a seven-page article written by Leibnitz, a noted German philosopher, in a monthly magazine called the *Acta Eruditorium* (the acts of the erudite).

One of the great personal controversies of science broke out with the appearance of this article. It appears that Leibnitz, when in his late twenties, had traveled to England in 1673 and had visited Oldenburg, Boyle and Pell, at the Royal Society. Newton, who had been a student of Isaac Barrow, a professor at Cambridge who had been working with the theory of infinitesimals in mathematics, was at the time developing a system of analysis which he called fluxions, but which he had not published. It was later charged by Newton's friends that Leibnitz had plagiarized when he published his article some eleven years later. The longer perspective of history has given credit to both men for independent discovery.

Leibnitz' article of seven pages on differential calculus and a similar one three years later on integral calculus set off a great wave of activity amongst philosophers and mathematicians on the continent. The Bernoulli brothers, John and James, professors at the University of Basel, Switzerland, began immediately to expand the principles of the calculus and to apply them to practical problems. One of their students, Leonhard Euler, who later became one of the principal professors at the St. Petersburg Academy and one of the most prolific writers in the field of mathematics, greatly expanded the calculus and solved many practical problems in mechanics and astronomy. The great activity following the disclosure of the calculus is one of many examples of the stimulation given to basic science through the pressure of need for solutions of practical problems.

Near the beginning of the 18th Century, the principles of fluxions were published by friends of Newton. Loyalty to Newton in the big debate over plagiarism delayed the publication of the calculus in the English language until 1816, when a translation of a French work on the calculus was made by three students at Cambridge, Babbage, Herschel and Peacock. In the meantime, the English mathematicians continued using the fluxions of Newton. Today it is universal practice to use the notation and procedures of Leibnitz.

The first complete book on the differential calculus was published anonymously in 1696 by the Marquis de l'Hopital. Since the marquis was a private student of John Bernoulli, it was long suspected that this book was prepared largely from the notes from Bernoulli's instruction. In recent years, Bernoulli's notes were found in the library at Basel, confirming the earlier conjectures. Later, de l'Hopital published a greatly extended work in his own name. The first book on the integral calculus was published in France in 1700 by Louis Carré. We thus see that the calculus has been available in book form only a little more than 260 years.

Galileo was the first to attempt the analysis of the strength of the beam, and published his work in 1638. Not until early in the 19th Century, however, was the behavior of the beam more completely analyzed. Galileo also founded the science of dynamics, and, also in 1638, he published an analysis of the trajectory of a projectile moving in a vacuum. At that time he also stated the first two of New-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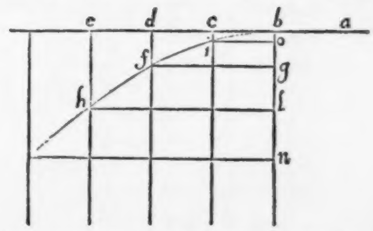
ſin qui dichiarate, non ſarà difficile l'intender la ragione, onde auuenga, che vn Priſma, ò Cilindro ſolido di vetro, acciaio, legno, ò altra materia frangibile, che ſoſpeſo per lungo ſosterrà graviſſimo peſo, che gli ſia attaccato, mà in trauerſo (come poco fà diceuamo) da minor peſo aſſai potrà tal volta eſſere ſpezzato, ſecondo che la ſua lunghezza eccederà la ſua groſſezza. Imperò che figuriamoci il Priſma ſolido A B, C D fitto in vn muro dalla parte A B, e nell' altra eſtremità s'intenda la forza del Peſo E, (intendendo ſempre il muro eſſer eretto all' Orizonte, & il Priſma, ò Cilindro fitto nel muro ad angoli retti) è manifeſto che douendoſi ſpezzare ſi romperà nel luogo B, doue il taglio del muro ſerue per ſoſtegno, e la B C per la parte della Leua, doue ſi pone la forza, e la groſſezza del ſolido B A e l'altra parte della Leua, nella quale è poſta la reſiſtenza, che conſiſte nello ſtaccamento, che s' hà da fare della parte del ſolido B D, che è fuor del muro, da quella che è dentro; e per le coſe dichiarate il momento della forza poſta in C al momento della reſiſtenza che ſtà nella

Prop. 4.

The work of Galileo provided a basis for the sciences of strength of materials and dynamics. Above is shown the page on which he set forth his theory of the cantilever beam (it was *almost* correct), and below is the explanation of projectile motion.

142 DIALOGO QVARTO

tionem quadratorum ipſarum, *c b, d b, e b*, ſeu dicamus, in ratione earundem linearum duplicata. Quod ſi mobili ultra *b* verſus *c* æquabili latione lato deſcenſum perpendicularem ſecundum quantitatem *c i* ſuperadditum intelligamus, reperietur tempore *b c* in termino *i* conſtitutum. Vlterius autem



procedendo, tempore *d b*, duplo ſcilicet *b c*, ſpatium deſcenſus deorſum, erit ſpatii primi *c i* quadruplum: demonſtratum enim eſt in primo tractatu, ſpatia peracta à gravi motu naturaliter accelerato eſſe in duplicata ratione temporum. Pariterque conſequenter ſpatium *e b*, peractum tempore *b e*, erit ut 9. adeo ut manifeſtè conſtet, ſpatia *e b, d f, c i*, eſſe inter ſe ut quadrata linearum *e b, d b, c b*. Ducantur modò à punctis *i, f, h*, rectæ *i o, f g, h l*, ipſi *e b* æquidiſtantes; erunt *h l, f g, i o*, lineæ lineis *e b, d b, c b*, ſingulæ ſingulis æquales; nec non ipſæ *b o, b g, b l*, ipſis *c i, d f, e h* æquales. Eritque quadratum *h l* ad quadratum *f g*, ut linea *l b* ad *b g*: & quadratum *f g* ad quadratum *i o*, ut *g b* ad *b o*. Ergo puncta *i, f, h*, ſunt in una eademque linea Parabolica. Similiterque demonſtrabitur, aſſumptis quibuſcunque temporis particulis æqualibus cujuſlibet magnitudinis, loca mobilis, ſimili motu compoſito lati, iiſdem temporibus in eadem linea parabolica reperiri. ergo patet propoſitum.

Salu-

DANIELIS BERNOULLI Joh. Fil.
Med. Prof. Basil.
ACAD. SCIENT. IMPER. PETROPOLITANÆ, PRIUS MATHESEOS SUBLIMIORIS PROF. ORD. NUNC MEMBRI ET PROF. HONOR.

HYDRODYNAMICA,

SIVE

DE VIRIBUS ET MOTIBUS FLUIDORUM COMMENTARII.

OPUS ACADEMICUM

AB AUCTORE, DUM PETROPOLI AGERET, CONGESTUM.

ARGENTORATI,

Sumptibus JOHANNIS REINHOLDI DULSECKERI,
Anno M D CC XXXVIII.

Typis Joh. Henr. Deckeri, Typographi Basiliensis.

MENSIS OCTOBRIS A. MDCLXXXIV. 467

NOVA METHODUS PRO MAXIMIS ET MInimis, itemque tangentibus, quæ nec fractas, nec irrationales quantitates moratur, & singulare pro illis calculi genus, per G.G.L.

SIt axis AX, & curvæ plures, ut VV, WW, YY, ZZ, quarum ordinatæ, ad axem normales, VX, WX, YX, ZX, quæ vocentur respective, *v*, vv, y, z; & ipsa AX abscissa ab axe, vocetur x. Tangentes sint VB, WC, YD, ZE axi occurrentes respective in punctis B, C, D, E. Jam recta aliqua pro arbitrio assumta vocetur dx, & recta quæ sit ad dx, ut *v* (vel vv, vel y, vel z) est ad VB (vel WC, vel YD, vel ZE) vocetur d *v* (vel d vv, vel dy vel dz) sive differentia ipsarum *v* (vel ipsarum vv, aut y, aut z) His positis calculi regulæ erunt tales: TAB. XII.

Sit a quantitas data constans, erit da æqualis o, & d ax erit æqu. a dx: si sit y æqu. *v* (seu ordinata quævis curvæ YY, æqualis cuivis ordinatæ respondenti curvæ VV) erit dy æqu. d*v*. Jam *Additio & Subtractio:* si sit z -y † vv † x æqu. *v*, erit d z--y † vv † x seu d*v*, æqu. dz--dy † dvv † dx. *Multiplicatio*, dx*v* æqu. xd*v* † *v*dx, seu posito y æqu. x*v*, fiet d y æqu. x d *v* † *v* d x. In arbitrio enim est vel formulam, ut x*v*, vel compendio pro ea literam, ut y, adhibere. Notandum & x & dx eodem modo in hoc calculo tractari, ut y & dy, vel aliam literam indeterminatam cum sua differentiali. Notandum etiam non dari semper regressum a differentiali Æquatione, nisi cum quadam cautione, de quo alibi. Porro *Divisio*, d $\frac{v}{y}$ vel (posito z æqu. $\frac{v}{y}$) d z æqu. $\frac{\dagger v\,dy \dagger y\,dv}{yy}$

Quoad *Signa* hoc probe notandum, cum in calculo pro litera substituitur simpliciter ejus differentialis, servari quidem eadem signa, & pro † z scribi † d z, pro--z scribi--d z, ut ex additione & subtractione paulo ante posita apparet; sed quando ad exegesin valorum venitur, seu cum consideratur ipsius z relatio ad x, tunc apparere, an valor ipsius dz sit quantitas affirmativa, an nihilo minor seu negativa: quod posterius cum fit, tunc tangens ZE ducitur a puncto Z non versus A, sed in partes contrarias seu infra X, id est tunc cum ipsæ ordinatæ

N n n 3 z decre-

The seventeenth and eighteenth centuries saw a flowering of scientific progress. Above is the title page from Daniel Bernoulli's *Hydrodynamics*, and at the right the beginning of the article in which Leibnitz set forth his theory of the calculus. It was published in the "Acta Eruditorium," a monthly magazine, in 1684.

ton's three laws of motion, which Newton acknowledged to be Galileo's work.

Many mathematicians undertook problems in dynamics following the disclosure of the calculus. The philosophical concept of forces and their behavior became a very hot subject. It was not until 1743 that the matter was settled by a young French philosopher and mathematician, d'Alembert, (editor, with Diderot, of the great French Encylcopédie) who published a work on dynamics shortly before his 27th birthday. This book is looked upon as one of the great classics in its field. The following year he published a book on the equilibrium and movement of fluids. This, likewise, settled many troublesome matters in current discussions relating to fluids. It was the next great step forward after Daniel Bernoulli's *Hydrodynamica*, which was published in 1738.

Combustion and heat were, in the earliest times, assigned mystical qualities of varying significance. As late as the 17th Century, heat was thought to be material, to have weight. Rumford and Davey, near the end of the 18th Century, recognized heat as a result of molecular motion.

The two brothers Montgolfier, near Lyons, built a spherical balloon of paper backed with linen. In 1783 they flew this balloon to a height of 6000 feet using warm air from a bonfire. Later that same year, the French physicist, Charles, flew a balloon filled with hydrogen. These two occasions initiated the first flight of man through the atmosphere. Charles, by the way, made a solo flight to an altitude of 9000 feet in his hydrogen balloon.

During the last half of the 18th Century, Black, Priestley, Rutherford and Cavendish, working in England with gases, made some very important observations and prepared the way for a more systematic approach to the subject of chemistry in France by Lavoisier, who was admitted to the Paris Academy of Sciences when he was twenty-five. Soon afterward he was appointed to a tax office and later became the director of gunpowder factories. Income from these sources made it possible for him to continue experiments which he conducted right up to the time of the Reign of Terror. Because of his positions in the monarchy and because they had "no need for men of science," they trumped up charges against him and executed him in 1794. He was then fifty-one. Although his work stopped, the impact of what he had done carried others on in founding the new system of chemistry.

Although in the 18th Century some experiments had been made in electrostatics, it was not until 1819 that Oersted discovered that when a wire was conducting a current of electricity, a compass held near it was deflected. This was the beginning of the experiments which finally led, about fifty years later, to the building of a practical dynamo and motor. The great development of the background theories now necessary for the modern work in electrical engineering has taken place largely during the last one hundred years. In that same century, all of the branches of science underlying engineering have been brought forward tremendously.

One point should be noted particularly and that is that the findings in any scientific field awaited practical application in the fields of technology. In this way medicine blends from science to technology; agriculture blends from science to technology; engineering likewise blends from science to technology. The useful results that affect our daily lives are the results of the work in technology. The underlying explanation of them is in the field of science. The two are intertwined inseparably and feed mutually one on the other.

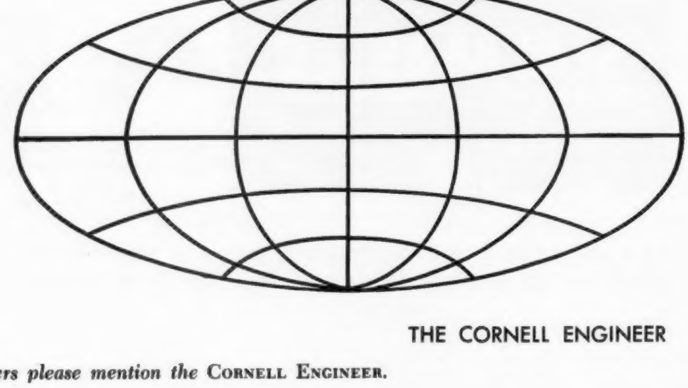
Engineering schools in the modern sense are relatively new developments, nearly all since the beginning of the 19th Century. Only in a few places was there any strength. In America by 1830 the strongest school in engineering was West Point. A review of its library of that date indicates that it was chiefly based on French work. As the civilian schools began to develop some twenty or more years later, they followed more closely the English tradition which was not so advanced as the French. Our language barrier held us back; and only in the last forty years have we begun to develop to anything like a full potential.

Another observation might be made from the foregoing recitation of developing events. Only a relatively short time ago, we were dealing with front-line developments that were new to the human mind and born with great effort through men of unusual ability. Today many of these subjects, in a rather extended form, are taught to our sophomores in engineering.

One may well be impressed with the strong procession of intellectual discovery during the last three centuries, proceeding regardless of the ebb and flow of political events. Turmoil silenced some, as it did Lavoisier; but it did not stop the flow, or lessen the inspiration, of the workers in these new fields. And these workers, be it noted, made their contributions as individuals.

Today the practice of engineering ranges from work in what is frequently called applied science to the practical and oft-times difficult task of bringing into operation a device, a system or a large work based upon this applied science. To those who do not know, this seems complex and in the end, mundane. But the underlying principles of science, of economics, of social and political function are always present in the engineer's work. He cannot neglect one for another. To bring forth great contributions to the community's service using all these branches of knowledge with wisdom and balance is his challenge; to succeed is his rich reward.

Finally, I would like to make a closing observation. When one reviews the list of great men whose powerful minds penetrated into the unknown and brought forth little by little the great system of scientific thought which we have as our heritage today, we cannot help marveling at the magnitude of their effort and the great beauty of their accomplishment. We walk with them in the paths of their thoughts in our daily work. This is a great privilege. It cannot help but give meaning and depth to the practice of engineering.



GRANT TO PROGRESS

by Harry Green III, ChemE '63

Is Cornell a great university? This is a question which can be argued pro and con with no definite answer. However, one of the aspects of greatness is to be strengthened at Cornell in the next few years. All great universities have strong graduate study departments with abundant facilities, fine professors, and provisions for aid to deserving students. Cornell's College of Engineering has already established its excellence in meeting these requirements. In the graduate field Cornell's excellence is to be further enhanced by a Ford Foundation Grant of $4,350,000 acquired in 1960. This is one of the largest grants ever made to any university or college, and is indicative of the efforts being made by University administrators to ensure Cornell's high standing in the graduate field.

Examination of the provisions of the grant reveals the steps to be taken in improving graduate study in engineering. A ten-to fifteen-year period is given in which to utilize a $2,200,000 endowment for eleven professorships. Furthermore, to each professorship which the University provides with $300,000, the grant will provide $200,000 for the full endowment of the chair. The eleven professorships will include five for assignment to senior faculty members already assigned to the staff, five new senior professorships, and one visiting professorship. An additional benefit in the form of salary increases for a limited number of the present engineering faculty will result from the release of the salary of the five senior professors appointed to the new positions. This part of the grant will serve to attract new qualified men to the staff and to hold the present faculty members.

Two further provisions which affect the present staff are a $300,000 fund for faculty development and a $350,000 discretionary fund. Present faculty members will be able to improve their capacity for graduate teaching using the faculty development funds. These funds, to be used over a period of ten years, can provide support for summer study groups; release time for special study during the academic year; or support any other programs which, in the opinion of the dean of the Engineering College, contribute to the capacity of the faculty for graduate education. Dean Dale R. Corson also has a $350,000 discretionary fund at his disposal which is to be used over a period of ten years for any purpose that will contribute to the quality of graduate education in the college. Starting promising young staff members on their research programs or financing the initial stages of the research programs of established staff members who venture into new fields are just a few of the possibilities. The flexibility of both of these components of the grant is very advantageous.

The Ford Foundation will also grant $750,000 to the university for buildings and facilities if Cornell obtains a like amount from other sources by September 1, 1962. Should this sum be raised, the total of $1,500,000 is to be used to provide:

1) $400,000 worth of laboratory and office space for the Radiophysics and Space Research Center;

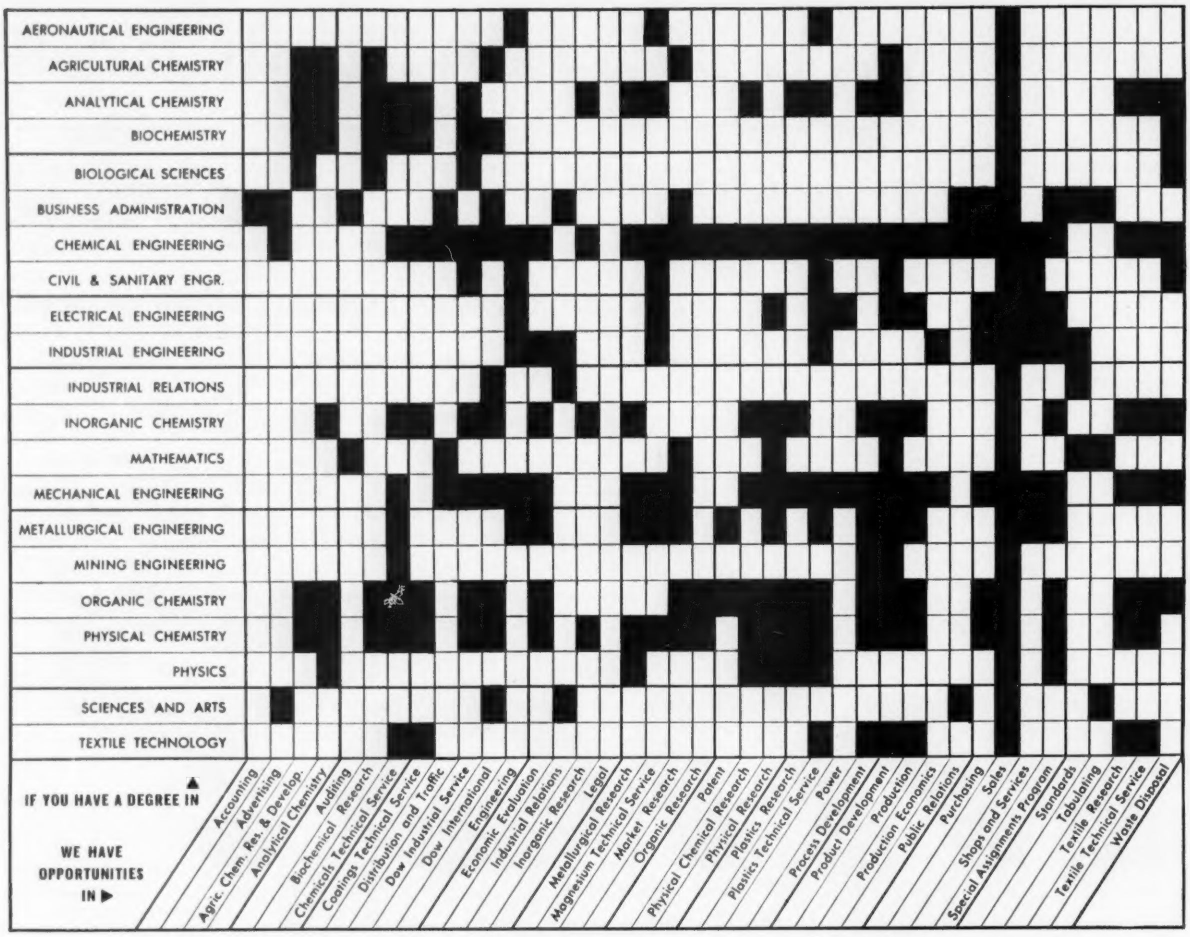
2) $100,000 worth of remodeling on the High Voltage Lab to provide laboratory and office space to be used in an energy generation or conversion research program;

3) money to repay the endowment funds from which the reactor facility was financed.

Provision is also made in the grant for financial support of promising pre-doctoral students. The two final components of the grant are especially interesting in that they limit financial support to doctoral candidates who have an interest in academic careers. This will encourage students to become teachers and will benefit the entire country's educational system as well as that of Cornell University. The first of the two components is a $500,000 grant to provide one part of a complete financial-support package for pre-doctoral students. This is to be used over the next five years. The other parts of the package will include part-time assistantships and other fellowships. The combined support packages will be on a twelve month basis and the total stipend can be up to $3,000 with not more than $2,000 plus tuition and fees from the Ford grant. One restriction is that the fellowship students must receive full residence credit.

The final component of the multi-million dollar grant is a $250,000 fund for loans to doctoral candidates who have a bona fide financial need in excess of $3,000 a year. These students may borrow up to another $3,000 per year from this fund, which has no time limit for consumption, and the loan will be forgiveable at the rate of twenty percent per year if the student follows an academic career. Again, this serves as further inducement to prospective teachers.

In view of the grant and its provisions, the benefits to graduate education at Cornell's College of Engineering are obvious. It is the effect on undergraduate studies that bears examining. Under Cornell's system of using graduate students as assistants and instructors, an improved graduate study program along with special inducement to those students persuing academic careers means a higher quality teacher for the undergraduate. Any steps taken to improve the capacity of the faculty for graduate study aids those who take undergraduate courses with graduate professors, or those who are qualified to take courses on the graduate level. The overall effort to help the staff, improve the facilities, and help the students will attract more promising high school graduates, thus improving the overall quality of the undergraduate student body. Certainly the efforts of Dean Corson and the rest of the administration should be given proper recognition and appreciation. The Ford Foundation grant is another step leading to a definite answer to the question, "Is Cornell a great university?"



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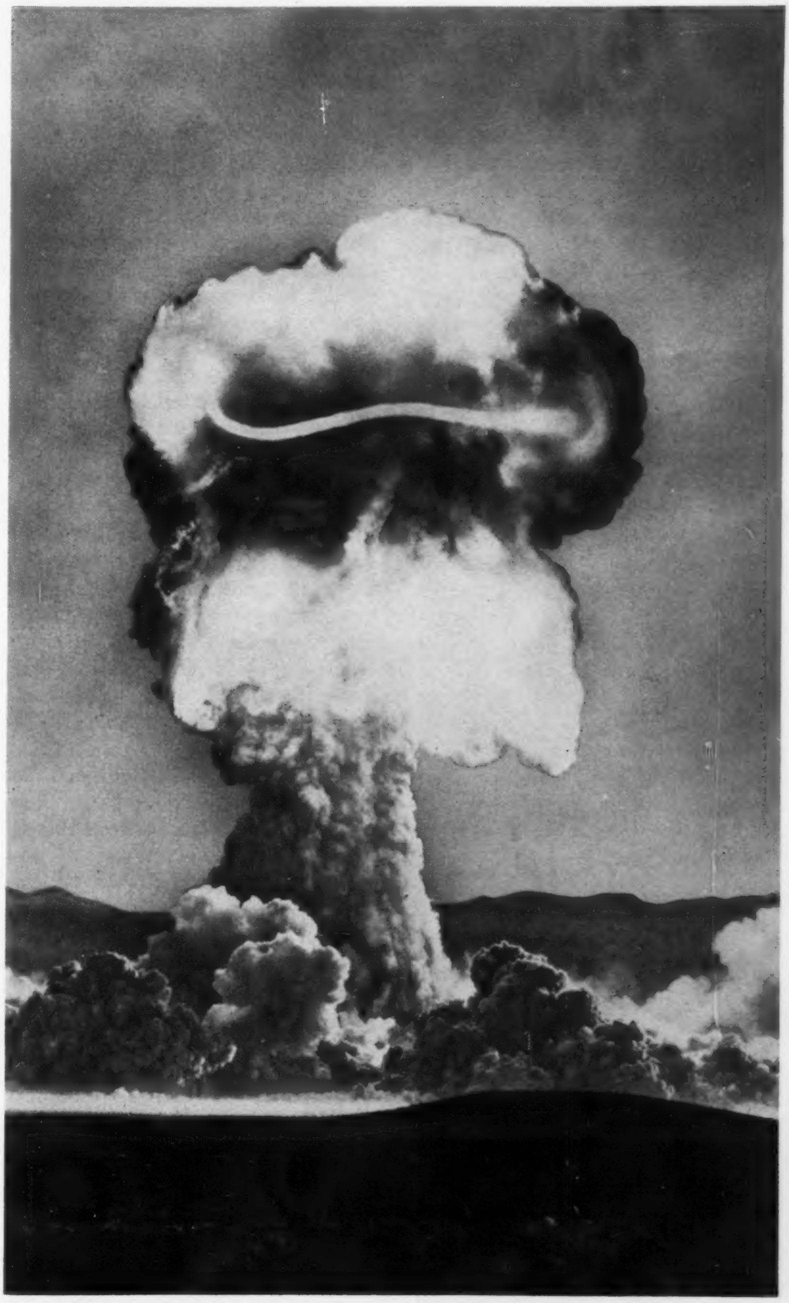
DISARMAMENT AND THE ENGINEER

by Lloyd S. Goldman, Arts '63

Along with the explosions of Russia's multi-megaton bombs in their recent series, there has been an explosion of world opinion in opposition to nuclear tests and, in general, to all forms of war and armament. In consequence of this, disarmament has become a popular topic of discussion both for the man-in-the-street and for the diplomat in his conference room. This does not mean to imply that disarmament is a recent innovation. Long before the development of the nuclear weapon, the prophets were asking humanity to beat their swords into plowshares and not to practice war any more. However, in our modern mechanized world, disarmament means more than just taking a few swords and shields out of the hands of a few thousand men. It means the dissolution of a giant complex of industries that has formed around the development and production of modern weapons of war and around the maintenance of armies numbering many hundreds of thousands of men. Besides the armament industry, it affects all other industries that are contracted by governments to supply armies with basic necessities; food and clothing, for example. The economic results of such a move as disarmament are immense. It is a very widespread belief among all classes of people that we avoided a disastrous depression of the proportions of the depression of the 1930's, if not greater in proportion than that, by



Atmospheric testing of nuclear weapons has touched off a wave of protest throughout the free world. Disarmament, if agreed upon, will have far-reaching consequences on the economies of the nations involved.

spending the enormous amount of money for war preparations characteristic of our country since World War II.[1] What the consequences of disarmament would be is a very important question, then, to everyone. The cessation of war expenditures means quite a bit to the taxpayer, because of the elimination of the tremendous tax-load being used for "national security" —a term that is becoming a misnomer daily as every new weapon, preparation, and advance leads us closer to war and insecurity, rather than toward national security. In any case, disarmament also means the loss of job opportunities in some fields and the creation of job opportunities in other fields. It is the question of this balance of employment with regard to the engineer that will be treated in this article.

The first aspect of this problem is that of the job opportunities that would be lost by disarmament. It is impossible to treat this problem in all of its facets with regard to the many industries involved in general disarmament. Therefore, in order to give some impression of the scope of this aspect of employment, it is necessary to select one item of war-time manufacture and to examine its development—discovering, in that way, the function of engineering in the production of war materials. The example used is taken from a British commentary on the programming and development of a number of heavy tanks over a period of time.[2] This is an instance, incidentally, of post-war or "cold-war" armament as opposed to actual war-time development.

Production and development of the tank, naturally, begins with its designing. After design, prototype tanks are built and tested. After final approval, the tank is ready for manufacture. Now, to manufacture the tank one needs to know the quantity of steel of different kinds it will require. This problem turns out to be more complex than one would expect. First, there is the steel required for the tanks. Then, there is the steel required to make the vehicles that transport the components from the subcontractors to the assembly plant and that carry the finished tanks from the assembly plant to the tank park. In addition, there is the steel required to make (1) the machine-tools to make the tanks, (2) the machine-tools to make the vehicles, and (3) the machine-tools to make both the other sets of machine tools. In the same manner, calculations are required to determine the amounts of coal, non-ferrous metals, rubber, instruments, and a variety of other materials and components—all of which have a limited supply—that are needed. Besides these, calculations must be made for the limited supply of labor—designers, draftsmen, managers, toolmakers, machinists, fitters, inspectors, and many more. All of this computation would be impossible without the advanced modern electronic computers of today. Further complications arise when some of the resources must be brought in from other countries. There is also the problem of phasing, beginning with the selection of people to be trained to make machine-tools which are used to make other machine tools, and ending, years later, with the completed products. Yet, with all the apparent complication of this process of manufacturing a tank, this item is relatively simple to manufacture compared to the processes that must be completed before the final production of a supersonic jet bomber or a multi-megaton bomb. In these projects, the number of men, man-hours, and the mass of complexities increases gigantically. Further, the participation of engineers of all types in production of these items of war is seen from the conception to the final product. Engineers involved in research and development, management, sales, and production are vital parts of any project of this sort. If we remove these projects of war, what happens to the army of engineers that is so deeply involved in the projects? Obviously, they are returned to the job market where they must seek re-employment.

Prof. N. W. Abrahams of Cornell's Mechanical Engineering Department is well qualified to discuss the problems of engineers in a situation of disarmament. Prof. Abrahams served in the Navy for many years, earning the rank of Captain. A discussion with this man brought out many points of interest and importance to the problem.

Drawing on his own experience with military engineering, Prof. Abrahams attempted to convey the immensity of the effect of disarmament upon the engineers in military service. He began by emphasizing the fact that all of the bureaus of the armed forces use engineers of one kind or another in their duties. Many of these men are highly-trained technicians who have been educated while in service—many of them at highly-rated engineering schools. These men are vitally important in the maintenance and proper operation of our mechanized forces. In the Navy, for example, Prof. Abrahams described how engineers were a necessary part of the construction and operation of a ship. The initial design of the hull is done by design engineers—usually trained in civil engineering. Engineers then begin designing and constructing the engine, shafting, propellers, and other parts of the drive systems. It is at this stage that metallurgical engineers play a major role by using their knowledge and experience to provide, as Prof. Abrahams says, "just that right touch" in the addition of the proper ingredients to an alloy that may go into the making of a propeller or other important part of the ship. Other engineers design the heating systems for the vessel. The electronic engineers attempt to improve on existing electronic gear or to develop new equipment where necessary, while electrical engineers plan new cables, turbo-generators, switches, distribution boards, and other devices that go to form the ship's "nervous system." Other engineering personnel design the shapes of fuel tanks, compute stresses and strains in timbers, plan deck plating or armor plating. After all of this is completed, testing engineers must check the work and, after the testing is done, the ship is turned over to operating engineers who monitor the equipment and guide the complex functioning of the various systems. In a disarmament situation, where armed forces are being reduced or disbanded, these highly-specialized technicians are thrust back into industry and must find some form of employment.

From an industrial standpoint, Prof. Abrahams referred to an article in *Register, the Defense Newsmagazine* that described a corporation formed to dispatch aviation engineers to all points of the world in order to keep military aircraft ultra-modern. The firm relies on the military aircraft for a source of income and would be affected seriously by a military reduction of planes and armament. In this way, the corporation is representative of many such companies who rely on government contracts for their existence.

Prof. Abrahams agreed with the hypothesis that many job opportunities would also become available in a disarmament situation. He suggested that, without the military priorities, more effort might be put into this country's space exploration and development programs. Another problem that might be improved by the influx of technical minds is that of our Merchant Marine. We have, according to Prof. Abrahams, a relatively small Merchant Marine compared to the size of our country. The men who are freed from their concentration on weapons and war could turn their thoughts to better ship and propulsion design for our Merchant Marine. In this manner, unemployed engineers could find constructive job opportunities in almost any field that can be improved or pioneered. This attitude will be discussed in somewhat greater detail later in the article. Any disarmament agreement must be maintained through an inspection system, but Prof. Abrahams remarked that this has relatively little effect on engineers, who might be called upon to help design inspection equipment, but who would not really find many job opportunities in the inspection system itself. As he talked, Prof. Abrahams often commented on the very great complexity and far-reaching effects of the disarmament question. It is this very complexity and uncertainty of this problem that is so frightening even to the expert.

The discussion with Prof. Abrahams leads to the second aspect of the disarmament problem: Will there be opportunities for those engineers made jobless by disarmament?

Examining this question, it is found that a disarmament situation floods the job market with highly-trained personnel possessing great technical know-how and experience. There exist today probably the greatest number of scientists ever employed on research. This is mainly due to military expenditure.[3] But if all of the scientific and engineering man-power wasted on military work (and in related industries) were transferred to peaceful occupations, there would still be a great deficiency in scientists and engineers with regard to the needs of our modern society.

Releasing the scientific and the technical workers that are, presently, employed by or for the military would force attention toward the solution of problems that are now being ignored. The progress of our age in many fields has been impaired due to the priority of national defense. Elimination of this priority frees the techniques of scientific study and research so that they may be applied to the advancement of methods of improving, rather than destroying, lives.

Along with the release of technically trained men, comes the release of billions of dollars that are annually tied up in defense. If only a fraction of these tax dollars are used to give better educational opportunities, the waste of human ability that is somewhat apparent today in our society could be corrected and used to make our society wealthier economically and intellectually. The time and money that is now being spent to improve isolated products could be used to better advantage in the improvement of our society and our way-of-life. Instead of designing a compact nuclear weapon, perhaps a scientist or engineer could seek more efficiency in our homes, offices, and schools. It appears that the problem of our society today is not unemployment, but rather mis-directed employment. Disarmament could force the issue to the point where science would seek after the constructive rather than the destructive influences to our society.

So far, in this article, it has been assumed that disarmament would mean wide-spread unemployment. Many economists do not feel that way. One source[4] concludes that war expenditures and war industries provide no net increase in employment. In fact, says this source, war expenditures and industries reduce employment by diverting national income to industries that produce less employment per dollar of expenditures than the consumer goods industries. The general feeling of the source is that the happenings in a period of disarmament in terms of employment depend on what policies are adopted by the government, which, in turn, depend on the political pressures exerted on the government. If disarmament is undertaken without any kind of compensating programs, severe difficulties would affect many workers. But with the proper political pressures applied, a wide variety of programs are possible. Some economists have gone as far as to say that disarmament will bring greater prosperity to the world than has

Without military priorities to claim their attention, scientists and engineers would be more free to conduct research and investigations of new fields of knowledge. The United States' efforts in space research, exemplified by the launching of this Vanguard satellite, could then be extended.

ever been known. But such an outlook can only be conjecture at present.

In any case, either view of the results of disarmament, positive or negative, implies that the disarmament will be total and instantaneous. In actuality, this action is unlikely to happen quickly and spontaneously. Disarmament, if and when it occurs, will probably be slow and methodical. By a gradual reduction of man-power and mechanization, there will not be a situation analogous to a "run" on a bank, but a slow and steady assimilation into an economy that will have time to adjust to the changes occurring in its midst.

If the positive view of disarmament turns out to be correct, the job-seeking engineer will find a greater market for his technical skills and our society and knowledge will both be benefited.

If, on the other hand, the negative view is the right outlook, then the economy is due for a serious disruption, and a depression followed by some resolution of the economy must be predicted. The engineer in that situation will not be able to use his skills, in general, but will have a tough enough time making ends meet.

In either case, the engineer will be undoubtedly affected by disarmament and must be conscious of the results of this action on his security. In many ways, the manner in which the engineer and scientist react to a disarmament situation may determine the path that our culture will take in future generations. Disarmament, then, is not just a political question, but a problem of great importance to all workingmen, especially to the engineer.

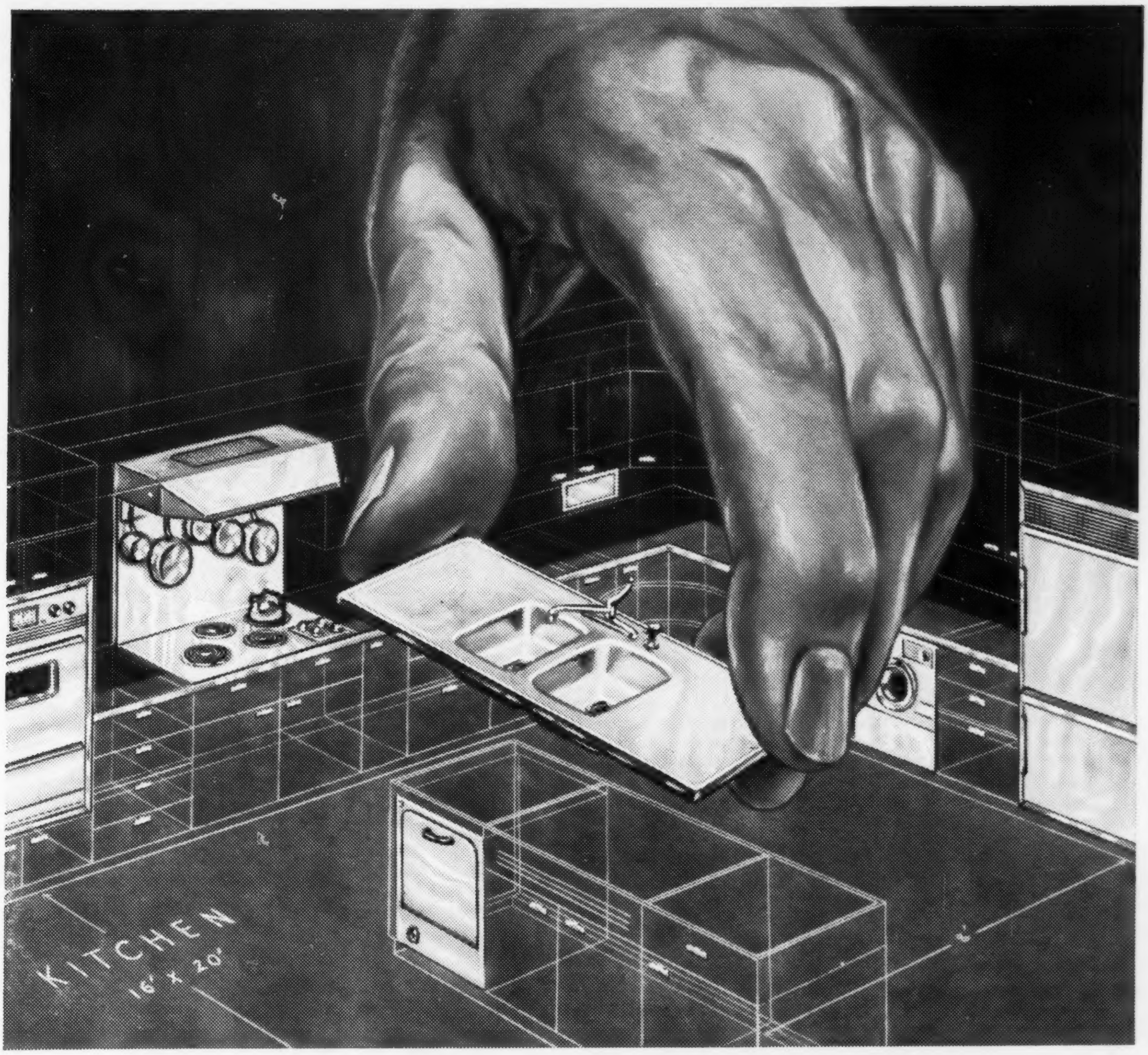
FOOTNOTES

1. Herbert Aptheker, "The Ideology of Disarmament," *Disarmament and the American Economy* (New York: New Century Publishers, 1960), p. 5.

2. Ian Mikardo, "The Economic Consequences of Rearmament and Disarmament," *World Disarmament* (London: National Peace Council), pp. 62–63.

3. John Eaton, "Economics of the Fight for Peace," *Disarmament and the American Economy* (New York: New Century Publishers, 1960), p. 59.

4. George S. Wheeler, "War Production and Employment," *Disarmament and the American Economy* (New York: New Century Publishers, 1960), p. 53.



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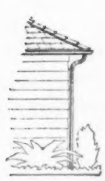

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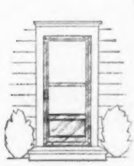

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UNION CARBIDE

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University News Bureau

The underdeveloped areas of the world need the means for increasing agricultural production and food supply in order to free more of the population for industrial endeavor. In this village market place in Nigeria, cassava, one of the bases of the native diet, is offered for sale. Introduction of modern agricultural methods and other crops will make diets more nourishing.

THE ENGINEER IN UNDERDEVELOPED SOCIETIES

by Rudolph Juliano, Arts '63

During the past several decades, many of the nations of the earth have been experiencing a continuing revolution, a revolution not of a political but of a social and economic nature. Some have termed this phenomenon "the revolution of rising expectations." The name is well chosen for this revolution consists of the growing realization on the part of the common peoples of Asia, Africa and Latin America that life need not consist solely of poverty, toil, disease and death. These people, the people of the underdeveloped lands, have, through their contact with western civilization, seen that the common men of a nation can attain a high standard of material well-being. They now seek to attain the same degree of well-being for themselves. Since the western nations owe their prosperity to the high degree of industrialization they have achieved, the underdeveloped lands seek to emulate them and to develop their own economies.

The gap between the traditional society of the underdeveloped lands and modern industrial society is a large one indeed. The former is a static society both economically and socially. Its economy, which is largely based on agriculture, generates enough capital only to perpetuate the society without expanding it. Its social

institutions are such as to keep the people living in accordance with the pattern of their ancestors. Conversely, modern industrial society is dynamic; growth and progress are integral parts of the social and economic structure. There is considerable social mobility; occupations, and thus patterns of living, are determined to a large extent by an individual's capabilities rather than by his family history.

From an economic point of view the process of economic development is merely one of getting the economy out of the traditional rut; to produce capital and grow in the "compound interest" fashion so characteristic of modern industrial society. However, the attainment of this end involves more than just a simple alteration of the economy. It involves rather a total revision of the whole traditional society; for the economy cannot be changed for the better unless the whole society is prepared to receive the effect the changes make. Thus the process of development is an integrated one in which changes in the economy are synchronized with changes in the social institutions, and in the values and beliefs of the people themselves.

Some of the changes which must be effected while the backward nation is developing the industrial capacity vital to a modern society are these: First, the country must institute a government capable of dealing with the problems of modern life. Second, it must develop suitable financial and commercial institutions. Third, it must acquire a sufficient amount of social overhead capital such as roads, railroads, and power facilities, so that it may manufacture its products and transport them to national and international markets at competitive costs. Last and most important, it cannot have an industrial economy unless its population is prepared to produce and consume efficiently in such an economy. That is, there must be a sufficient number of people willing and able to direct a modern economy. There must also be enough native technical people and industrial workers to run the new industries, and there must be a populace with the ability and desire to consume a large share of the nation's industrial output.

The western engineer, whether he be employed by some agency such as the International Cooperation Administration, by the native government, or by private industry, plays an important role in several phases of the transition from traditional to industrial society.

In agriculture, the introduction of more advanced farming methods such as irrigation, wells and storage facilities creates great increases in farm productivity and farm income. Land, which in the traditional society could barely feed its inhabitants, can, in the industrial society, produce far more with less labor. The surplus food will be needed by the urban industrial workers, who themselves will be drawn from the surplus supply of rural labor resulting from the increase in productivity. The increase in productivity occasioned by the introduction of new techniques should also be accompanied by an increase in income, enabling the farmers to become consumers of some of the manufactured goods of the newly industrialized society.

The role of the engineer in the construction of roads, railroads, ports, and dams is a very familiar one, for the construction of these things presents, essentially, the same problems in the underdeveloped land as elsewhere. The importance of this familiar task cannot be underestimated, for these public facilities are the basis of any industrial society.

The role of the engineer in the development of the industrial sector itself is a twofold one. In his first capacity he acts as a sort of modern Prometheus, bringing to the underdeveloped lands the great backlog of technical information that the western nations have accumulated. This role of the engineer is most valuable in the industries which comprise the so-called "leading sectors" of the economy. These are industries such as textiles and oil, which mature

Technicians and engineers from the more developed areas of the world foster international cooperation by aiding those in less industrialized countries. Here, Harold M. Jones, M.S. in Agricultural Engineering '47, demonstrates operation of a threshing machine while working for the U.S. International Cooperation Administration in India.

far more rapidly than the rest of the economy, either because of some special natural advantage or the existence of a readymade domestic or external market. In these leading sector industries, the most modern techniques are often used. In other areas of the industrial establishment, the role of the western engineer is more a tutorial one. It is his task to instruct the native technical people and to cooperate with them in the development of industrial techniques adapted to the special needs of the nation. In this capacity the engineer may face tasks that range in complexity from advising on the production of mud bricks in the Middle East to finding ways to utilize very low grade iron ore in Africa.

The effect of the successful introduction of new techniques and equipment on a backward community may best be understood by means of an example.

The city of Asuncion, the capital of Paraguay, was until recently without a wholesome and sanitary supply of milk. Milk, of low quality to begin with, often passed through the hands of as many as six primitive and unhygienic dealers before reaching the consumer. In the process it was often adulterated with flour or other ingredients.

To remedy this situation, the technicians of the International Cooperation Administration erected a model dairy on four hundred acres of land granted by the Paraguayan government. Since Paraguayan cows were inferior milkers, the I.C.A. imported a herd of fine cows from Argentina.

Milk from the model dairy was sold to schools, hospitals and to a limited number of private customers. The clean and wholesome milk was so highly esteemed that one citizen bequeathed his place on the dairy delivery list to his next of kin.

The demand for milk became so great that sixty-one private dairies utilizing modern methods were established. Hundreds of fine dairy cattle were imported to improve the herds of the new dairies.

The improved herds of cattle required a higher quality of feed than was available. This demand for quality feed induced 8 private producers to open modern feed mills based on the example of the one in operation at the model dairy.

When the I.C.A. felt assured that Asuncion possessed an adequate supply of milk, production was discontinued and the model dairy was turned over to the local agricultural college for instructional purposes.

The results of the I.C.A. project in Asuncion shows what western technicians can do at their best. Not only did Paraguay acquire new industry in the form of numerous dairies and feed mills; but in addition to this, agriculture was improved through the introduction of improved cattle. Moreover, its educational system profited by the acquisition of new facilities. There was an increase in international trade in the form of the cattle imported, and, most important, the health and welfare of the people of Asuncion was enhanced by the plentiful supply of clean, wholesome milk which resulted.

The westerner has not in all cases fulfilled the ideal role which has been prescribed for him. When he has failed, his failure may sometimes be attributed to a lack of understanding of the nature of economic development and of the conditions he faces in the underdeveloped lands.

One criticism of present methods of development is that all too often engineers have undertaken projects, at the behest of nationalistic leaders, for which the nation involved was totally unprepared. This policy has resulted in "islands of progress in a sea of backwardness". Small pockets of western civilization have arisen leaving the bulk of the society in its traditional state. In other words, too many steel mills have been built in nations whose people still till the soil with sharp sticks.

Another criticism of contemporary methods is that small projects which would be of benefit to people immediately tend to be overlooked in favor of large, long term projects. That is to say, that while the building of oil refineries and concrete plants are readily undertaken, village improvement, sanitation and health are often neglected. This approach is undoubtedly justifiable and perhaps even commendable from an economic standpoint, but it is hardly so from a humanitarian one.

A third criticism of today's methods of development is that they are often capitally over-intensive; that is, they require a high investment of capital relative to other factors. This is a great disadvantage to the underdeveloped nations, since it is very difficult for them to obtain the necessary capital. Moreover, a capitally intensive method of development ignores the one great resource of the underdeveloped lands: their vast supplies of inexpensive labor.

The failures of engineers in the backward lands may be attributed in part to mistakes on the part of the planners. However, to some extent they are due to the inability of engineers to adapt modern technology to the special problems of the underdeveloped lands. Western engineers have come to feel that a certain capital investment in machinery and raw materials is necessary to the successful undertaking of a task. Yet there are many jobs in the underdeveloped lands that need doing, but for which there is essentially no capital available. Jobs like these can be done, as experience in India and elsewhere has shown, but most western engineers are scarcely ready to do them.

The process of economic development is extremely complex and little understood. Yet this much may be said about it—the introduction of new technology plays a vital role in the metamorphosis which changes a traditional society into a modern one. For it is modern ideas and modern methods which break the bonds that hold traditional society in its static state. It must be remembered that these new ideas and methods are but seeds, and for them to grow and spread they must be adapted to their new environment. The western engineer in his role of transmitting and adapting these methods and ideas is faced with many difficulties. But he is also faced with a great opportunity—the opportunity to sever for all times the chains of hunger, disease and toil that bind two-thirds of mankind to an existence unbelievably wretched.

CORNELL SOCIETY OF ENGINEERS

"The objects of this Society are to promote the welfare of the College of Engineering of Cornell University, and to foster a closer relationship, than would otherwise be the case, between the College and its alumni for the benefit of that institution."

THE PRESIDENT'S LETTER—

The October Executive Committee meeting held in Ithaca proved again to be a valuable forum for the Society and Engineering College representatives to discuss problems of mutual concern, exchange ideas, and initiate new courses of action.

Dean Corson spoke at length of two vital challenges to the progress of engineering education at Cornell. The foremost challenge is represented by the successful establishment of the Division of Basic Studies, a two-year program designed to give students a more comprehensive picture of engineering problems and methods before they choose particular fields of interest. Executive Committee members and the Dean explored in detail the problems of revising certain courses in the initial two years of the curriculum, of stimulating student interest, and of maintaining a practical proportionment of students in the various divisions of the College at the end of the second year. We plan to keep you abreast of the latest developments in this program in future columns.

Secondly, the Dean emphasized the need for alumni support to maximize the benefits of the Ford Foundation grant of over $4 million to the College of Engineering. Specifically, the sum of $200,000 has been allocated to each of eleven professorships by the Ford grant. These eleven chairs may be perpetually endowed if additional gifts of $300,000 for each chair are received. Please let us hear from you if you are interested in perpetuating the great influences these professorships will have on the Engineering College.

Another area of mutual concern for the Cornell College of Engineering and the Society is the decrease in admissions, a situation that is being experienced by many engineering schools across the nation. Student Personnel Director, Donald Moyer, recognized the valuable aid engineering alumni have given in the past in secondary school work but stressed the need for even greater efforts in the future. Apparently, many qualified high school seniors are being influenced by the emphasis put on science and overlooking the opportunities and exciting challenges present in engineering careers. This may be due, in part, to their failure to receive a realistic picture of those opportunities and challenges. Perhaps here is an opportunity for Society members, working through local Secondary School Committees, to help reverse this trend.

University Placement Director, John Munschauer, discussed present operations and problems of his office. In particular, he expressed appreciation to the Society for its financial support of the New York Placement Office. The Society considers the work of this office as an essential aid to the alumni in the Greater New York Area and, as such plans to continue its support in the future.

The Ithaca meeting also proved profitable in furthering internal objectives of the Society. Three regional representatives, namely, John Ehret from Chicago, Walter Hickey from Boston, and Ladimir "Red" Zeman from Cleveland, were present and discussed programs, finances, and publicity for the coming year with members of the New York Chapter. Dates of meetings and reports of activity of the regional chapters will appear periodically in a new column in the Alumni News section of the *Cornell Engineer*. We are hopeful that alumni in other areas of the nation will be interested in participating more actively in Society work. We welcome your inquiries.

Editor-in-Chief Theodore Spar, Managing Editor Mary Ann Huber, and Business Manager Donald Martin, all of the *Cornell Engineer*, met with Executive Committee members to work out problems of closer liaison between the two groups. A major change in the format of the Alumni News section of the magazine was agreed upon so as to allow added flexibility in the presentation of Society news and alumni activities. Plans were discussed for the appearance of periodic feature articles by alumni in a special column in the magazine. Your comments and ideas for such a column are invited.

A final highlight of the Ithaca meeting was the reception at the Big Red Barn for the Faculty of the Engineering College. The discussions with the men so much responsible for the Cornell accent on progress, the accent represented by the new curriculum and the expanding areas of research on the engineering campus, fill one with pride at being associated with such a great university.

Your president was pleased to be in Ithaca also on another occasion—to bring the greetings of the Society to the new Ithaca section of the New York State Society of Professional Engineers at its first meeting on Thursday, October 19. The charter of the section was signed by the charter members, many of whom are Cornell faculty or alumni. I was pleased to witness also the presentation of the Professional Engineer license to Dean Dale R. Corson by Leland R. Post, Chairman of the New York State Licensing Board.

The first Fall Society meeting was held in New York on October 17. About sixty members gathered to hear Fred Wood, C.E. '24, Consulting Engineer and University trustee, talk on "Utilization of Space." The "space" he dealt with concerned educational buildings—how we can stretch the capital investments in such buildings, as related to student population, by more intensive scheduling of classroom and laboratory use. The talk provoked a lot of interesting discussion and Fred was kept busy for some time answering questions.

This meeting was scheduled during the Annual A.S.C.E. meeting and, as a result, attracted a number of out-of-town members that we rarely see at a meeting. The social hour was a very pleasant time spent in renewing old friendships and making new ones. The range in classes represented was 1905 to 1961. Our next two meetings are planned to coincide with the A.S.M.E. and A.I.E.E. Annual Meetings, so all of you M.E.'s and E.E.'s attending those affairs, please plan to join us for an evening of fellowship.

PAUL O. GUNSALUS

ALUMNI ENGINEERS

Edited by Harry Green III, ChemE '63

Joseph Pursglove, Jr., B.C.E., '30, received the 1961 Bituminous Coal Research Annual Award for outstanding leadership on behalf of industry-sponsored coal research this summer. Mr. Pursglove, Vice-President of Research and Development for the Consolidation Coal Company of Pittsburgh, earned the ninth annual award for his exemplary achievement in promoting research support. He has been Vice-President of Research and Development of Consolidation since 1947, and he is responsible for the largest research program ever undertaken by a single coal company. The program involves research in many fields, including economical methods of converting coal into chemicals, special carbons, gaseous and liquid fuels, and the pipe-lining of coal to markets. This research is done by a technical staff of 160 working at the company's research center.

After graduation from Cornell, Mr. Pursglove worked with coal companies in Ohio, Pennsylvania, West Virginia, and Illinois, gaining experience in mine operations. He also designed and directed the construction of several coal preparation plants and other aboveground coal-handling facilities. In 1946, he became head of Consolidation Coal's Research and Development division and began full-time studies of methods for converting coal into chemicals, and gaseous and liquid fuels.

Mr. Pursglove is a director of BCR and of Atomic Power Development Associates of Detroit, president of Mountaineer Carbon Company, a coke calcining firm formed jointly in 1956 with the Standard Oil Company of Ohio, a member of the Pennsylvania Coal Research Board, and a member of numerous other technical groups.

Roy J. Lamm, B.Ch.E., '61, has joined the Cracking and Light Ends Department of Process Technical Division at Humble Oil and Refining Company's Baytown, Texas, refinery. He is engaged in technical work related to refinery process plants that manufacture lubricating oils. This includes long-range planning for expansion and the development of new and improved lubricants.

Mr. Lamm received his degree in June after being on the Dean's List for four years. While at Cornell, he was secretary of the student chapter of the American Institute of Chemical Engineers, and assistant editor of the *Cornell Engineer*. He was the 1958 winner of the Engineering College Magazines' first prize for the best non-technical article written.

The next regularly scheduled meetings of the Cornell Society of Engineers will be:

30 November in conjunction with the New York Convention of the American Society of Mechanical Engineers. William Littlewood, M.E. '20, University Trustee and past Society President will be the guest speaker.

31 January 1962 in conjunction with the American Institute of Electrical Engineers.

3 May 1962 The Annual Meeting at which Dean Dale Corson will speak.

All meetings are in New York and will be held in addition to the regional meetings in various other cities.

Robert A. Woodle, B.Ch.E., '44, is a co-patentee of a recently issued Patent U.S. 2,943,037 assigned to Texaco Inc. covering improvements in naptha treating processes.

Mr. Woodle joined Texaco as a chemical engineer in the Port Arthur, Texas, Research Laboratory after graduation in 1944. He has held a succession of assignments and is now Supervisor of Lubricants Research. He is a member of the American Chemical Society and is the author of several technical papers. He holds several other patents in the field of petroleum technology.

Edward R. Bergun, B.C.E., '52, has been appointed Liquefied Petroleum Gas Facilities Engineer at Shell Oil Company's head office in New York City. Mr. Bergun started with Shell in 1952 and has had construction and project engineering assignments at the Norco Refinery in Louisiana. He is a past president of the Cornell Club of New Orleans, and a member of the Cornell Society of Engineers.

Alumni News

Robert Jorgenson

Robert Jorgenson, B.S.M.E. '48, was chairman of the Industrial Ventilation Symposium at the 68th Annual Meeting of the American Society of Heating, Refrigerating and Air-Conditioning Engineers this summer. The subject of the Symposium, held in Denver, Colorado, was Laboratory Hood Design. Mr. Jorgenson is presently Assistant Chief Engineer for the Buffalo Forge Company.

H. Andreas von Biel, EE '55, author of "Moon Bounce and Signals from Space" printed in Summer 1961, *Research Trends* at

CAL is an Associate Electrical Engineer in the Laboratory's Radio Physics Section of the Applied Physics Department. He is project engineer for the investigation of the lunar surface and properties of the auroral ionosphere by radio propagation.

Born in the United States of German parents, Mr. von Biel received much of his elementary and secondary education in Germany. Upon returning to America following World War II, he entered Cornell University from which he holds Bachelor's and Master's degrees in electrical engineering. While completing requirements at Cornell for the advanced degree, Mr. von Biel served as teaching assistant here.

Before joining the Laboratory in 1959, he was on active duty with the U.S. Navy as electrical and C.I.C. officer.

Mr. von Biel's professional specialties are radiowave propagation antennas and communications. He is a member of Sigma Xi.

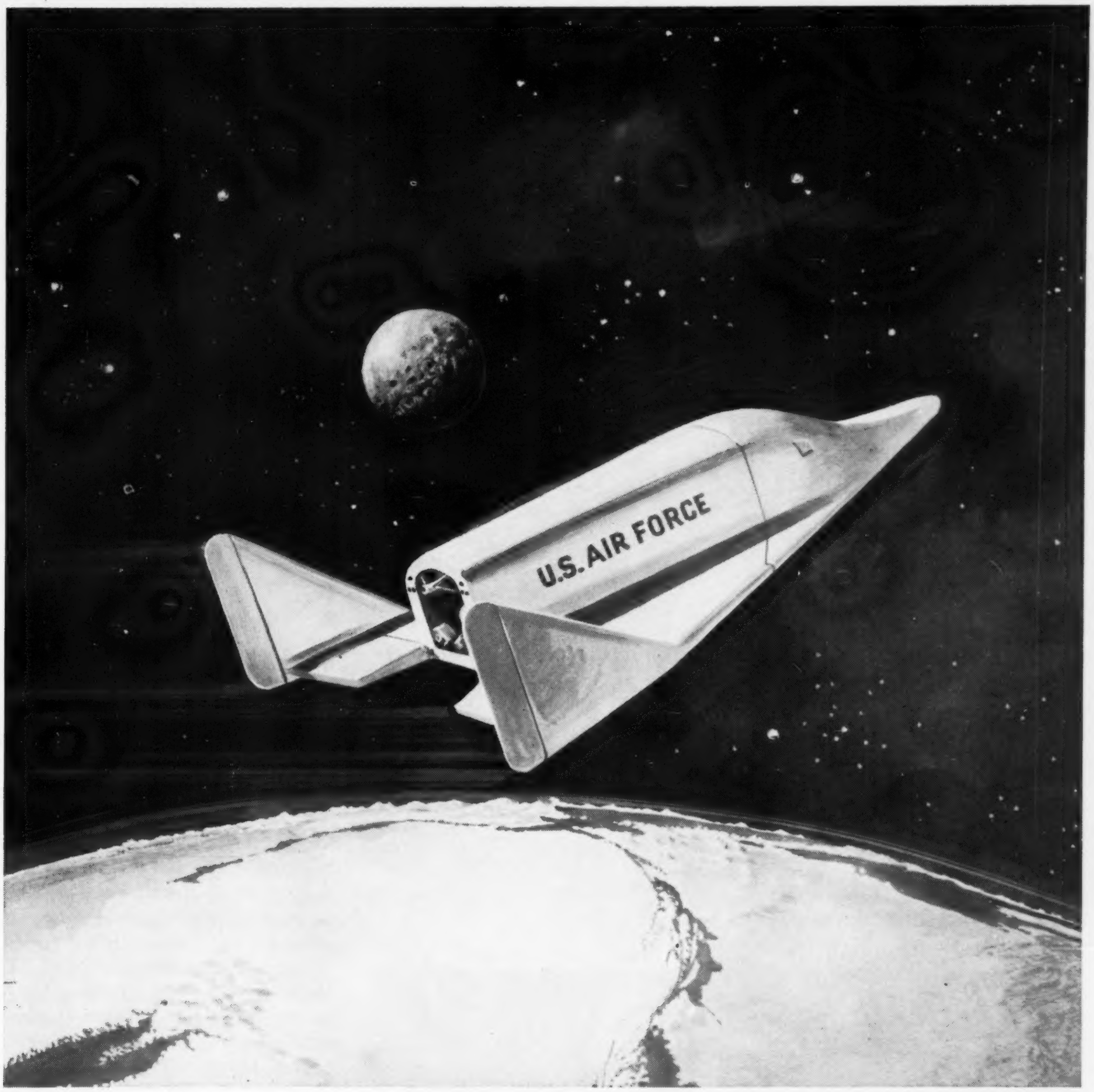
D. N. Parks, Jr., B.Ch.E., '57, recently rejoined Humble Oil and Refining Company after completing three years in the U.S. Navy. He was assigned to the butyl and butadiene section of the Butyl, Butadiene, and Solvents Technical Division at Baytown Refinery in Texas. In this position, he will be engaged in process control and design associated with the butyl polymerization unit.

After graduation, Mr. Parks worked several months in the Technical Division at Baytown Refinery before entering the Navy. He was a navigation and communication officer on the USS Corry, and later at Guantanamo Naval Base was an instructor and assistant communication officer with the fleet training group. He attained the rank of Lieutenant, J.G.

Vincent deP. Gerbereux, M.E., '24, was recently named Director of Marketing Services of Worthington Corporation, one of the leading manufacturers of a highly diversified line of capital goods equipment and machinery. Mr. Gerbereux, formerly General Manager of Worthington's Standard Pump Division at East Orange, New Jersey, will now have his offices at the company's headquarters in Harrison, New Jersey. He will be responsible for corporate-wide product planning, marketing research, sales training, parts service, advertising and sales promotion, and marketing services.

Mr. Gerbereux joined Worthington after graduating from Cornell and entered the company's Student Engineer Training Program. After completing the program, he successively served as a centrifugal pump designer and an application engineer until he was made assistant manager of the Centrifugal Pump Division in 1937. In 1951 he became manager of the division and in 1955 was named General Manager of the company's newly formed Standard Pump Division.

A licensed Professional Engineer in the State of New Jersey, Mr. Gerbereux also holds memberships in the Technical Association of the Pulp and Paper Industry and the Cornell Society of Engineers. He is currently serving as President of the Hydraulic Institute, having previously held the posts of Chairman of the Executive Committee and Vice-President.



Cooling space pilots from launch to landing

New concepts in airborne cooling have become vital to the progress of America's space program. For example, Garrett is now developing an advanced system for the Boeing Dyna-Soar manned space glider. It will use the liquid hydrogen fuel for the vehicle's own accessory power system to control the temperature of the pilot and equipment throughout the flight. This is another of the many systems in development by Garrett to further the conquest of space.

Project areas at Garrett with which you might wish to become identified include space life support systems, solar and nuclear power systems, electronic systems, air conditioning and pressurization systems, computer systems and small gas turbines for both military and industrial uses.

Available to newly graduated engineers is a several month orientation program to help you determine your future.

For further information about a career with The Garrett Corporation, write to Mr. G. D. Bradley in Los Angeles. Garrett is an "equal opportunity" employer.

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COLLEGE NEWS

Edited by Robert Stern, EE '63

CORNELL PROFESSOR WINS ASCE AWARD

Prof. George Winter, Head of the Department of Structural Engineering, Cornell University, has been named the recipient of the 1961 J. James R. Croes Medal of the American Society of Civil Engineers, it was announced at Society headquarters in New York.

The award is made annually to the author, or authors, of a technical paper which is judged worthy of special commendation for its merit as a contribution to engineering science. Prof. Winter's winning paper, which was published in a 1961 volume of ASCE's "Transactions," was entitled "Lateral Bracing of Columns and Beams."

Prof. Winter was invited to receive the award, a gold medal, at the annual convention of the Society in New York City in October.

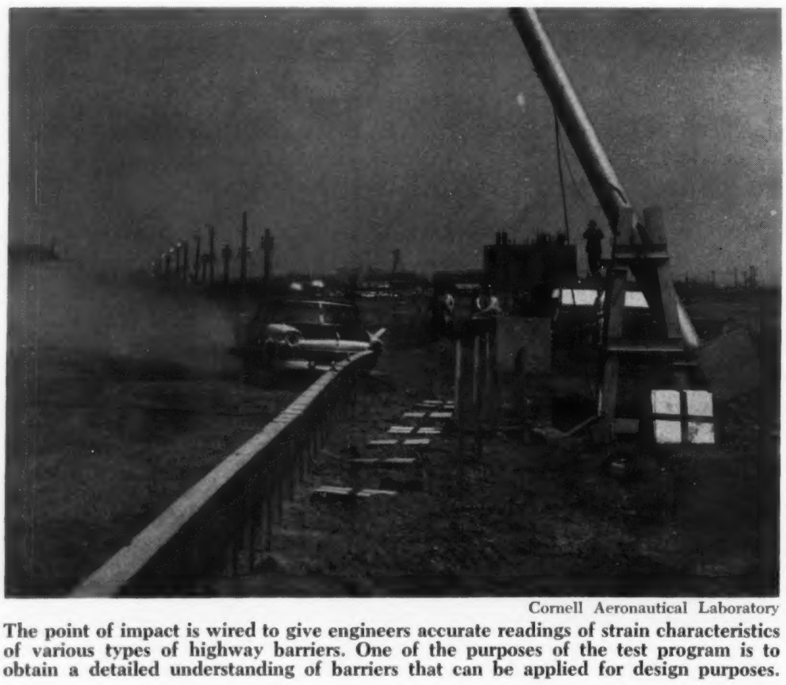
HANS BETHE RECEIVES 1961 FERMI AWARD

Hans A. Bethe, renowned nuclear and theoretical physicist and professor of physics at Cornell University, has been named to receive the U.S. Atomic Energy Commission's Enrico Fermi Award for 1961.

The award consists of a gold medal, a citation and $50,000. It will be presented to Professor Bethe in recognition of his outstanding contributions in the fields of nuclear and theoretical physics which helped to establish the foundations of nuclear physics and nuclear technology, in the applications of atomic energy for the betterment of mankind, in weapons technology, and as a teacher and a leader of men.

The citation of Professor Bethe reads: "For contributions to nuclear and theoretical physics, to peaceful uses of atomic energy, and to the security of the United States."

Professor Bethe will become the fifth recipient of the award upon the recommendation of the Commission's General Advisory Committee and with the approval of President Kennedy.



Cornell Aeronautical Laboratory

The point of impact is wired to give engineers accurate readings of strain characteristics of various types of highway barriers. One of the purposes of the test program is to obtain a detailed understanding of barriers that can be applied for design purposes.

The award will be presented to Professor Bethe in a ceremony to be held in the auditorium at Commission headquarters at Germantown, Md., on Friday, Dec. 1, 1961, the eve of the 19th anniversary of the memorable day—Dec. 2, 1942—when Enrico Fermi and his group of scientists successfully operated the world's first nuclear reactor under the stands at Stagg Field, University of Chicago, and proved that a nuclear fission chain reaction could be self sustained and controlled.

The unanimous recommendation of the General Advisory Committee that Professor Bethe receive the Fermi Award was contained in a letter from Dr. Kenneth S. Pitzer, chairman of the Committee, to Dr. Seaborg. The recommendation summarized Professor Bethe's achievements as follows: "Dr. Hans A. Bethe has contributed to the progress of nuclear energy in many ways. He has carried out a number of fundamental studies in nuclear physics and in several other fields. These studies helped to establish the foundations of nuclear physics and nuclear technology. He has written review articles on branches of physics which have helped many other physicists to become acquainted with these important areas of physics so that they might go on to make substantial contributions to these fields themselves.

"He made great and lasting contributions to weapons technology during the war against the Axis powers and during the subsequent years he has coupled these activities with work directed toward peaceful applications of nuclear energy. Through this busy and productive period, he has remained an outstanding teacher and leader of men.

"He has had many gifted students and has had a great influence on them and his colleagues. His insight and knowledge at-

tracted many young men who were past the years of formal study into his circle.

"There is no question but that he fully qualifies for the great distinction for which we propose him."

Professor Hans A. Bethe

CAL CRACKS UP CARS IN THE INTEREST OF SAFETY

Automobile accidents occur on schedule at Cornell Aeronautical Laboratory.

In the interest of highway safety, cars are being cracked up to determine how future highway guide rails and similar barriers should be designed. The research program, which has demolished four autos in as many tests, is sponsored by the New York State Department of Public Works with financial assistance from the federal Bureau of Public Roads.

One of the main purposes of the program, according to Norris E. Shoemaker, project engineer, is to obtain a detailed understanding of barriers subjected to vehicle impact that can be applied for design purposes. "Until now," he explained, "the familiar fences which line our highways have been designed from experience—not true scientific knowledge."

Shoemaker's preliminary report reveals that there are important differences in the extent of hazards involved in striking barriers of various types at sharp angles and high speeds. The impact is often too sudden, causing occupants of the auto to be seriously injured.

Paradoxically, one of the factors which led to the research program by New York State was the increasing use of modern, "safer" highways. Widespread use of expressways and parkways has greatly reduced the automobile accident rate, but not eliminated it. The periodic occurrence of cars going out of control and crossing median sections of divided highways has contributed to the decision to conduct the current research program.

Future barriers, described as continuous structures at the edges of roads, will undoubtedly be built to "protect rather than warn," according to Shoemaker.

"Now," he said, "we are expanding the research previously accomplished in the field, thereby gaining a better understanding of the variables that influence barrier—vehicle performance."

Once an understanding is reached, he believes, it will be possible to cope with new vehicle and highway developments without continually resorting to test programs.

What does Mr. Shoemaker think the barrier of the future will be?

"When impact occurs, a successful barrier will redirect the vehicle along a path parallel to the barrier. The vehicle will then be stopped gradually instead of suddenly—as is often the case today.

"The problem isn't simply devising a means of preventing vehicles leaving the highway. The barrier should hold or deflect the vehicle back onto the roadway with minimum obstruction to traffic and with minimum injury to occupants."

The basic research problem arises in predicting the level of protection offered by a given highway barrier system under crash conditions. In the research approach adopted by CAL, engineers have crashed obsolete State Police cars into various types of barriers to collect experimental data for verifying the analytical phase of the program.

A network of electronic and photographic equipment was devised to record findings. Engineers traveling in a "chase car" operate the crash vehicle by radio control, sending it into the barrier at a predetermined speed and angle.

Many days, even weeks, are spent preparing for a test which is over in a matter of seconds. Instrumentation must be checked and rechecked. When the test is finally conducted, the car must hit a precise spot on the barrier if findings are to be recorded accurately.

DRAVO AWARDS MADE TO ENGINEERING STUDENTS

Six engineering students and their schools have received grants totaling $9,000 through the annual college and university scholarship program of Dravo Corporation, Pittsburgh.

The six awards include two students each from Carnegie Institute of Technology, Cornell University and Lehigh University.

Designed to assist outstanding students and encourage them in engineering careers, the awards consist of $1,000 toward each student's tuition and fees and $500 to his college's general fund. To be eligible for these scholarships a student must be entering his last two years of undergraduate work. Scholarships may be renewed for a second year if students maintain necessary standards.

Grants are based on financial need, scholarship, leadership, and personal characteristics which indicate potential ability to succeed.

A new scholarship was granted to: James B. Fedele, 30 Odell Avenue, Endicott, N.Y.; mechanical engineering, Cornell.

Awarded a scholarship for the second year was: Joseph D. Dreyfuss, 218 Dearborn Place, Ithaca, N.Y.; civil engineering, Cornell. Since its establishment in 1954, the Dravo scholarship fund has made $81.000 in grants available to 30 students and their colleges.

ENGINEERING SALARIES STILL INCREASING, SAYS MOYER

Beginning salaries for graduating engineers at Cornell University are four per cent higher this year than last, Donald H. Moyer, director of the office of student personnel for the College of Engineering, announced.

The engineering placement office, releasing its figures on this year's graduating seniors, reported that in the seven divisions of the college some 274 students re-

ceived degrees. Of these, about 119 were placed through the office at salaries ranging from $444 to $833 a month, with a median of $566 a month for all graduates.

Most graduates were in mechanical engineering, which has the greatest enrollment, and of these 41 were placed in positions, with a median salary of $555. Next in number of graduates were electrical engineering with 59 and civil engineering with 44 graduates. Electrical and metallurgical engineering showed the greatest jump in median salaries over last year's figures.

All of the figures showed an increase over last year, reflecting the increasing engineering enrollment at Cornell and a steady, nationwide salary rise. Generally, salaries for Cornell engineers have gone up three to five per cent yearly for the last several years.

This summer, Dean Dale R. Corson of the college reported that Cornell's enrollment in engineering continues slightly above the national average.

Of this year's graduates, 34 went into the armed services and 91 entered graduate school. No figures are available on salaries for graduates with advanced degrees, but these engineers have no trouble finding positions. Mr. Moyer reported that the increase in graduate enrollment may reflect a growing interest in research and development.

Reporting on salaries in the field, Mr. Moyer commented that significant changes have occurred during the 60's. Previously, engineers were hired at good salaries but reached a plateau midway in their careers, after which it was difficult to rise without entering some phase of administration. Increasingly, and especially in large corporations, exceptional professional engineers are being better paid than formerly without the need to resort to administrative work.

Reporting on placement interviews conducted on the Cornell campus this spring, he noted 234 engineering seniors utilized placement facilities on campus for 3200 interviews or an average of 13.7 interviews per student. About 350 companies recruited engineers at Cornell.

GRAPHITE-COATED NUCLEAR FUEL SIMPLIFIES HEAT EXCHANGE

Use of existing high efficiency steam generating equipment coupled directly to an economical nuclear reactor is feasible employing a new nuclear fuel. Fueled Pressure Spheres developed by High Temperature Materials, Inc. will allow generation of uncontaminated 1200° F. steam at 5000 psi without auxiliary heating or heat exchangers.

Radioactive by-products of the fission process are contained in conventional reactors by isolating complete stages with heavy shielding, intermediate heat exchangers and elaborate purification systems. The pressure spheres contain these fission gases within an impervious pyrolytic graphite coating applied over each separate fuel particle. The fact that pyrolytic graphite will not react with most available coolants affords significant construction and operating economies by allowing direct generation of uncontaminated steam.

The high temperature strength provided by the PG coating allows operation at efficient reactor temperatures without the dissipation of radioactive by-products. At 4500° F. the pressure of fission gases to be contained within each fuel particle would reach 80,000 psi but would require only 40 to 80 microns of PG over a 100 to 300 micron diameter fuel particle.

Significant savings in fabrication and handling costs result from the combination of impermeability and strength unique to pyrolytic graphite. The coated, sand-size fuel particles have been dispersed within 2½ inch graphite balls using low cost techniques to attain near optimum fuel density. These balls may then be loaded and unloaded from a reactor as though they were tennis balls pouring from a can.

The integrity of the coated particles has been subjected to rigorous testing; particles have been cycled from room temperature to 3632° F. repeatedly, followed by boiling in nitric acid. These tests have shown no increase in activity over background levels. Irradiation tests by the Atomic Energy Commission at the Oak Ridge National Laboratory are being conducted.

TECHNIBRIEFS

Edited by Harry Green, Ch.E '63

SUN-POWERED ELECTRIC PLANT COULD FEED MILLIONS

A small self-contained electric power plant and pumping unit, capable of sustaining individual families or villages by irrigating the land they live on and supplying their household water needs, is the first step toward improving the standard of living.

A prototype of such a system, including a fifty-watt power plant, has been built and tested. Developed in cooperation with the Solar Energy Laboratory of the University of Wisconsin, the experimental unit taps the heat energy of sunlight and converts it directly into electricity by means of a thermoelectric generator. The power generated drives an electric motor having a water pump connected directly to it. These are the only moving parts in the whole irrigation system.

The thermoelectric generator will be the subject of a report by Kurt Katz, senior engineer at the Westinghouse new products laboratories. It will be delivered at the United Nations Conference on New Sources of Energy in Rome, Italy.

A larger solar-thermoelectric system, scaled up from the fifty-watt version, is now under development and has been operated at part power. This unit will have a capability of up to 200 watts of electric power. It will pump enough water from a depth of 20 feet to irrigate approximately four acres of land at the rate of 24 inches of water a year. This is about the average annual amount of precipitation in Minneapolis, Minn., or Honolulu, Hawaii. The unit can supply the personal needs of 1200 people on the basis of five gallons of water per person per day.

To provide the stated amount of water, the system must operate 10 hours a day for only 250 days of the year. This leaves a safety margin of about one-third of the year to provide for cloudy weather, when the solar-thermoelectric generator would not operate.

The solar-thermoelectric system uses an eight-foot saucer-shaped (parabolic) mirror which gathers the sunlight and focuses it on the thermoelectric generator. The generator is a metal "box" about eight inches on a side and about two inches thick. One face is black, to more efficiently absorb the heat of the sunlight shining upon it.

Inside the generator are seventy-two thermoelectric elements, or couples, each composed of a "leg" of p-type semiconductor material and one of n-type. Like all thermoelectric materials, they have the unique ability to generate an electrical voltage when heated to a higher temperature on one side than on the other.

The seventy-two thermoelectric couples are connected together electrically in series so that their voltages add together. The entire generator, which weighs just over 16 pounds, was fabricated at the Westinghouse semiconductor department.

The generator can operate with temperatures on its hot side as high as 1100 degrees F. However, in order to extend generator lifetime and reduce the initial cost of the system, especially the mirror, an operating temperature of 840 degrees F. (about twice the broiling temperature in a kitchen range) has been adopted. The cool side of the generator runs at 150 degrees F.

SCIENTISTS DEMONSTRATE 'MOLECULAR SLIDE RULE'

Scientists at the Westinghouse research laboratories have demonstrated a unique electronic device which might best be described as a "molecular slide rule."

The tiny device electronically performs multiplication and division by a process similar to that used in the familiar mechanical slide rule so widely used for mathematical calculations, yet the new multiplier-divider has no conventional electronic components or circuitry. It is simply a solid slice of silicon about the size of the head of a thumbtack and as thick as a few sheets of paper.

The molecular slide rule is the latest subsystem, or functional electronic block, to be demonstrated by Westinghouse through the principle of molecular electronics. It does away with traditional circuits built from arrays of electronic components such as tubes, transistors, resistors, and the like. Instead, the same function is performed by rearranging the internal structure of a solid semiconductor crystal. Electronic behavior occurring within or between regions in the crystal gives the same effect as an entire electronic circuit (subsystem), or even a whole system.

The multiplying and dividing function performed by the new functional block is equivalent to that done by an array of four separate diodes, or three diodes and a transistor. The functional block, however, is capable of greater accuracy than the assembly of individual components.

Four Westinghouse scientists, H. C. Lin, C. E. Benjamin, P. W. Smith and B. S. Aronson, all of the electronic department of the Westinghouse research laboratories, developed the unique device.

Westinghouse previously has announced some 20 other functional electronic blocks capable of performing a dozen different kinds of electronic functions. Many of the blocks were developed under a research and development contract with the Electronics Technology Laboratory of the Aeronautical Systems Division (ASD), U.S. Air Force.

The new functional electronic block multiplies by adding together voltages that are logarithms of the quantities to be multiplied.

The logarithm of a number is the power to which a fixed base number (usually 10) must be raised in order to equal the number (called the antilogarithm).

A slide rule is marked off in logarithmic scales and is labeled with the corresponding antilogarithms. To multiply two numbers, the sliding and fixed scales are adjusted to add their logarithms. The product, or antilogarithm, is then read directly from the instrument.

The molecular slide rule performs in a similar way, but electronically by means of semiconductor junctions. An electric current fed into a junction gives a voltage across the junction proportional to the logarithm of the current. An input of two currents into two junctions gives a voltage which is their logarithmic sum. The antilogarithm, measured at the output of the functional block, is the product of multiplying them togther.

Just as in a slide rule, division is the opposite process. The currents are fed into the multiplier-divider in such a way that their two logarithms subtract instead of add.

Used for multiplication or division, the new device has an input range of 10 to one and an output range of 100 to one. Its accuracy in multiplying—dividing is within five percent.

MICROWAVE MEASUREMENT KIT AIDS SCIENCE TEACHERS

A new low-cost electronic "science teacher" that simplifies the study of energy radiation at speed of light has been developed by the Budd-Stanley Company, Incorporated, manufacturer of microwave test instruments and components.

Called an Ed-Set, the new "electronic teacher" is the first completely assembled instrument of its kind available to high school and college science departments for demonstrating optics and microwave theory. The new portable demonstration unit is also expected to find wide use in military technical schools and in companies with in-plant training systems.

Through simple experiments, an instructor or student can use the Ed-Set to illustrate the basic natural laws of light or measure electromagnetic radiation—energy "pulse beats" at thousands of millions of cycles per second.

So that students can be trained in using standard test equipment, a resonant-cavity-type frequency meter is provided, as well as variable flap attenuator and a sliding probe carriage with millimeter scale and vernier for measuring S.W.R.

Radar signals can also be sent along a section of hollow metal tubing across a 30-foot classroom and through solid walls, with interference patterns measured, plotted and calculated.

The Ed-Set is expected to fill a teaching gap in current high school and college science courses caused by the lack of "packaged" microwave equipment. According to a Budd-Stanley executive, few of the nation's estimated 40,000 school science laboratories stock optics-microwave demonstrators which up to now have had to be assembled piecemeal at costs ranging from $1,500 to $4,000.

The new Ed-Set will be sold to schools for $385. It contains all components in one package—power supply, amplifier, tube mount, frequency meter, attenuator, slotted line, crystal detector and accessories.

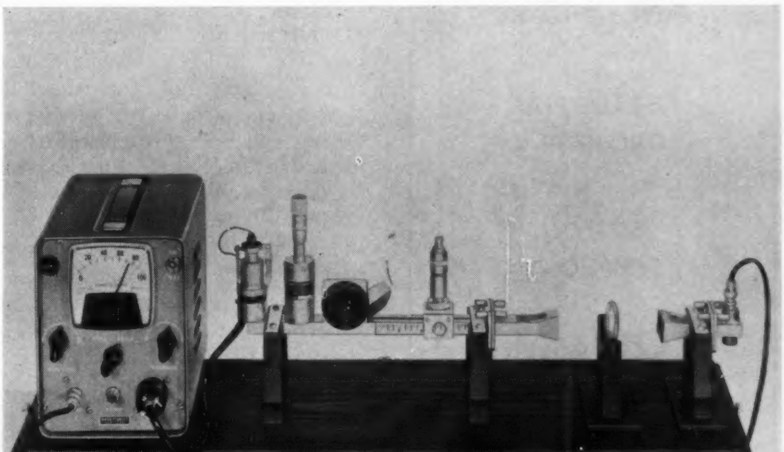
In accuracy, the new electronic instrument approximates standards of laboratory precision sufficient to measure the speed of light with a margin of error not exceeding nine per cent.

Completely portable, the demonstration unit weighs only 33 pounds with carrying case and can be plugged into any standard 110-volt, 60-cycle AC outlet. It stands one foot high and is approximately 11 inches wide by 31 inches long. An easy-to-read instruction manual and demonstration accessories are shipped free with each unit.

ECHO SUPPRESSOR TO MAKE SATELLITE CALLS POSSIBLE

An electronic device designed to solve one of the basic problems which would arise in space communications was introduced by scientists of General Telephone & Electronics Corporation.

Known as an "echo suppressor", the device is designed to "silence" echoes which would occur in telephone conversations between widely separated parts of the world, using a space satellite as a relay station. The device was displayed at the Global Communications Symposium (GLOBECOM), sponsored jointly by the American Institute of Electrical Engineers and the Institute of Radio Engineers.



Budd-Stanley Company

The new portable microwave demonstration set made by the Budd-Stanley Company, Syosset, New York, is the first preassembled unit available to high school and college science departments for teaching optics and microwave theory.

According to Dr. Herbert Trotter, Jr., President of General Telephone & Electronics Laboratories, GT&E research subsidiary, telephone communications employing a satellite system would be unfeasible unless such an echo-reducing device were part of the system. He pointed out that the echo of an individual's voice, while not rendering speech completely unintelligible, would have the "inevitable effect of leading the speaker to enunciate too slowly and jerkily, and would interrupt trains of thought, thus resulting in unsatisfactory or even worthless conversation."

However, he added, the GT&E "echo suppressor" would enable a satellite system to carry "natural telephone conversations".

Dr. Larry Hunter and James Stewart of the GT&E Laboratories operation in Menlo Park, Calif., inventors of the device, described the "echo suppressor" as being capable of operating in two "modes".

In "mode 1" there is complete echo suppression while one person is "doing all the talking" without interruption from the person on the other end of the circuit. An open switch breaks the circuit in the non-used direction of transmission so there is no path by which the echo may return to the talker.

"Mode 2", according to Dr. Hunter and Mr. Stewart, becomes operable in the device—automatically and not noticeable to the talkers—when one person is talking and the other person interrupts. In "mode 2", they stated, "partial echo suppression is achieved by inserting 'loss', or attenuation, in the transmission paths. If the same amount of 'loss' is inserted in each path, the echo suffers twice as much loss as the signal, and therefore, with a reasonable amount of 'loss', the echo becomes unnoticeable while both speakers are talking". In this "mode", the switch must be closed to permit transmission in both directions at the same time. Closing the switch makes it possible for the echo to return to the talker. To reduce the effect of this echo, "loss" is introduced by electronic methods of control.

Emphasizing that the "echo suppressor" still is in the developmental stage, the two scientists said their work with the device indicates that "with partial echo suppression during interruptions and with complete suppression for normal conversational interchange, high quality telephone service by means of satellite systems will be possible".

They said the complex device could be adapted to either low-altitude or high-altitude satellite systems, and also to long-range land-line systems.

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The lower-altitude system would use forty or more satellites launched into random polar orbits about 3,000 miles high. Because they would be in random orbits not paralleling the direction of the earth's rotation, the individual low-altitude satellites would not be in constant contact with any single ground station. As a satellite passed out of sight of a ground station which was transmitting via the satellite to another ground station also in line of sight of the satellite, both stations would rotate their antenna to establish contact wih an oncoming satellite. This switching process would require equipment capable of solving mechanical and electrical problems not present in a high-altitude system with its fixed line of sight between satellite and ground stations.

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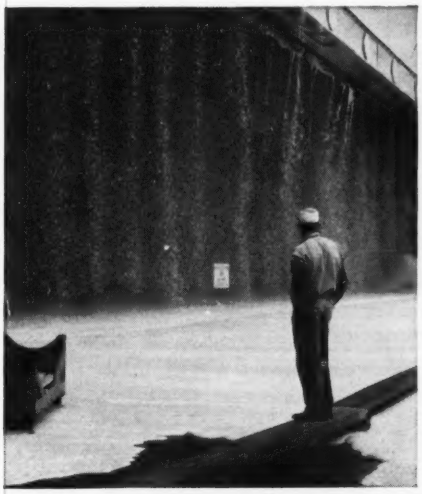

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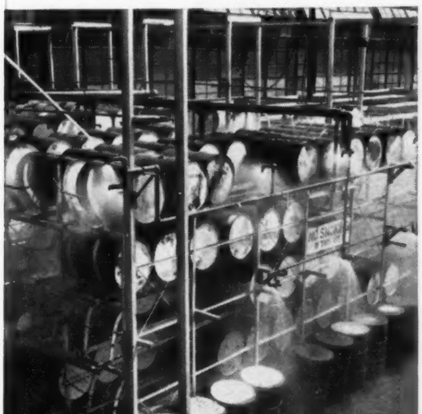

pray, applied to outside storage of paints and sol- ools to inhibit internal pressure build-up and dilutes nt flammable vapor-air mixtures from developing.

SPECIAL FIRE HAZARD	WATER SPRAY	FOAM	CARBON DIOXIDE	DRY CHEMICAL
→ AIRCRAFT HANGARS	✓	✓		
ALCOHOL STORAGE	✓	✓	✓	
AMMUNITION LOADING	✓			
AMMUNITION MAGAZINES	✓			
ASPHALT IMPREGNATING	✓			
BATTERY ROOMS			✓	
CARBURETOR OVERHAUL SHOPS	✓	✓	✓	✓
CLEANING PLANT EQUIPMENT	✓	✓	✓	✓
DOWTHERM	✓			
DRYING OVENS	✓		✓	✓
ENGINE TEST CELLS	✓	✓	✓	
ESCALATORS, STAIR WELLS	✓			
EXPLOSIVES: MANUFACTURING, STORAGE	✓			
FLAMMABLE LIQUIDS STORAGE	✓	✓	✓	
FLAMMABLE SOLIDS STORAGE	✓			
FUEL OIL STORAGE	✓	✓		
HANGAR DECKS	✓	✓		
HYDRAULIC OIL, LUBRICATING OIL	✓		✓	
HYDRO-TURBINE GENERATORS	✓		✓	
JET ENGINE TEST CELLS	✓	✓	✓	
LIGNITE STORAGE AND HANDLING	✓			
LIQUEFIED PETROLEUM GAS STORAGE	✓			
OIL QUENCHING BATH	✓	✓	✓	✓
→ PAINTS: MANUFACTURING, STORAGE	✓	✓	✓	✓
PAINT SPRAY BOOTHS	✓		✓	✓
PETROCHEMICAL STORAGE	✓	✓	✓	
PETROLEUM TESTING LABORATORIES	✓	✓	✓	
PRINTING PRESSES			✓	
REACTOR AND FRACTIONATING TOWERS	✓			
RECORD VAULTS			✓	
RUBBER MIXING AND HEAT TREATING	✓			
SHIPBOARD STORAGE	✓		✓	
SOLVENT CLEANING TANKS		✓	✓	✓
SOLVENT THINNED COATINGS		✓	✓	✓
SWITCHGEAR ROOMS			✓	
TRANSFORMERS, CIRCUIT BREAKERS (outdoors)	✓			
TRANSFORMERS, CIRCUIT BREAKERS (indoors)	✓		✓	
TURBINE LUBRICATING OIL	✓	✓	✓	✓
VEGETABLE OIL, SOLVENT EXTRACTION	✓	✓		

There's a Grinnell Fire Protection System to protect every type of property. Grinnell designed and installed systems are backed by over 90 years of fire protection experience. Grinnell Company, Providence 1, Rhode Island.

GRINNELL

FIRE PROTECTION SYSTEMS SINCE 1870

NGINEERING GRADUATES HAVE FOUND ATTRACTIVE OPPORTUNITIES WITH GRINNELL

According to Dr. Herbert Trotter, Jr., President of General Telephone & Electronics Laboratories, GT&E research subsidiary, telephone communications employing a satellite system would be unfeasible unless such an echo-reducing device were part of the system. He pointed out that the echo of an individual's voice, while not rendering speech completely unintelligible, would have the "inevitable effect of leading the speaker to enunciate too slowly and jerkily, and would interrupt trains of thought, thus resulting in unsatisfactory or even worthless conversation."

However, he added, the GT&E "echo suppressor" would enable a satellite system to carry "natural telephone conversations".

Dr. Larry Hunter and James Stewart of the GT&E Laboratories operation in Menlo Park, Calif., inventors of the device, described the "echo suppressor" as being capable of operating in two "modes".

In "mode 1" there is complete echo suppression while one person is "doing all the talking" without interruption from the person on the other end of the circuit. An open switch breaks the circuit in the non-used direction of transmission so there is no path by which the echo may return to the talker.

"Mode 2", according to Dr. Hunter and Mr. Stewart, becomes operable in the device—automatically and not noticeable to the talkers—when one person is talking and the other person interrupts. In "mode 2", they stated, "partial echo suppression is achieved by inserting 'loss', or attenuation, in the transmission paths. If the same amount of 'loss' is inserted in each path, the echo suffers twice as much loss as the signal, and therefore, with a reasonable amount of 'loss', the echo becomes unnoticeable while both speakers are talking". In this "mode", the switch must be closed to permit transmission in both directions at the same time. Closing the switch makes it possible for the echo to return to the talker. To reduce the effect of this echo, "loss" is introduced by electronic methods of control.

Emphasizing that the "echo suppressor" still is in the developmental stage, the two scientists said their work with the device indicates that "with partial echo suppression during interruptions and with complete suppression for normal conversational interchange, high quality telephone service by means of satellite systems will be possible".

They said the complex device could be adapted to either low-altitude or high-altitude satellite systems, and also to long-range land-line systems.

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Extinguishing blanket of foam completely covers the floor of this aircraft hangar. 5,897 foam-water sprinklers protect property worth a billion Air Force Defense dollars.

Water spray, applied to outside storage of paints and solvents, cools to inhibit internal pressure build-up and dilutes to prevent flammable vapor-air mixtures from developing.

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CLEANING PLANT EQUIPMENT	✓	✓	✓	✓
DOWTHERM	✓			
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SOLVENT CLEANING TANKS		✓	✓	✓
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SWITCHGEAR ROOMS			✓	
TRANSFORMERS, CIRCUIT BREAKERS (outdoors)	✓			
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FIRE PROTECTION SYSTEMS SINCE 1870

ENGINEERING GRADUATES HAVE FOUND ATTRACTIVE OPPORTUNITIES WITH GRINNELL

FIFTY YEARS AGO IN THE ENGINEER

Edited by Barry Beindel, EE '65

The remarkable luminosity of neon can be utilized for lighting purposes. One of the difficulties of the problem is the ease with which neon is masked in luminous tubes by small quantities of certain other gases. It is not sufficient to introduce very pure neon into a tube with electrodes, under suitable pressure, in order to obtain an effective luminous tube, for the gases disengaged from the electrodes and from the walls by the current almost destroy its luminous power. This can be overcome by the use in a special way of Dewar's discovery of the absorbant properties of charcoal at low temperatures. In fact neon is not so easily liquified as the other gases introduced or set free by the passage of the current, and is therefore less easily absorbed than they are by charcoal at the temperature of liquid air. In this way neon is purified, and after prolonged treatment the beautiful orange luminescence appears and retains its brightness. This bright light is very rich in red rays and is just the corrective required for the light of vapor tubes; in many cases it could be used alone as for studios, halls and so forth.

—*The Sibley Journal*, November 1911

Recovering gold from the Colorado river is being attempted by dredging the Grand Canyon. The prospects are said to be very alluring although it remains to be seen whether they will come up to the expectations or not. Nature has there prepared a gigantic sluiceway which has been working for ages tearing away the rocks. It is highly probable that there are considerable quantities of gold and platinum safely bound in the sand and gravel of the river bed which have never been operated upon because of the extreme difficulty in getting at the bottom of the river to dredge.

—*The Sibley Journal*, November 1911

A battery truck crane for the handling of freight has recently been devised by the General Electric Company. These cranes are driven by a battery in the rear of the truck. They are used on such freight as can be divided up into parcels of 1 ton or less which have to be moved through a vertical distance of not over ten feet and in a radius of eight feet. For transportation of loads over large areas not exceeding 400 feet in length these battery truck cranes are attached to trailers which carry the parcels to the various points. The crane is then used in placing the loads. At the Bush Terminal in New York 600,000 pounds of cotton were moved half a mile in ten hours, taking 24 bales at every trip, averaging one trip every twelve minutes. This gives an average of 500 pounds per minute over a distance of half a mile.

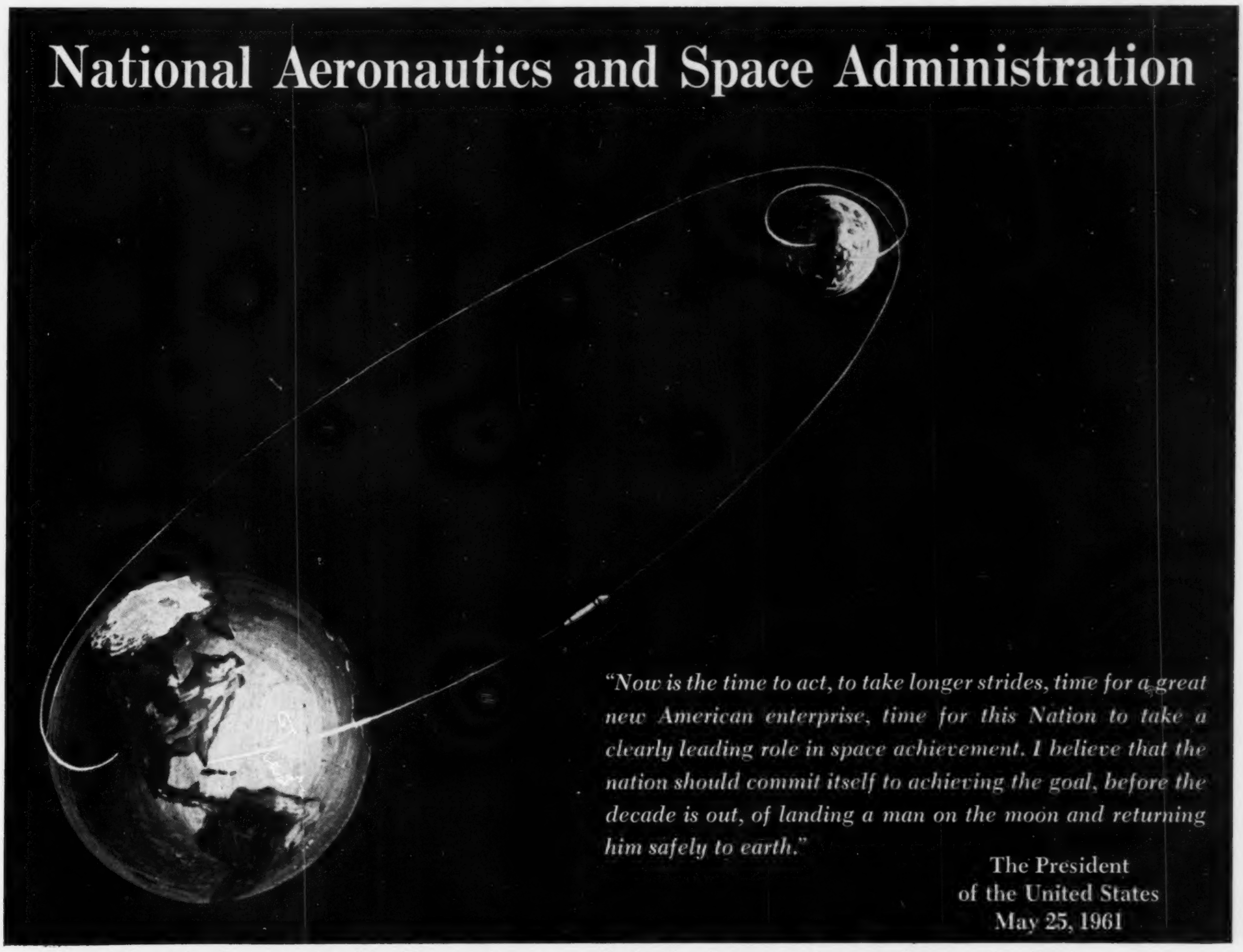
—*The Sibley Journal*, November 1911

The Swiss National Railways are soon to give up their present method of operating on steam power. This power is to be replaced by the use of a single phase, overhead conductor, 15,000 volt system. The first portion of the work of electrifying the system will be done on the St. Gothard line. Eventually the work will extend to the whole Federal system of 1830 miles. The cost is estimated at $13,140,000 and the running expenses are estimated at ten per cent less than the cost of operation by the present steam power.

—*The Sibley Journal*, November 1911

Beads of metallic titanium have been produced recently by Matthew A. Hunter, in the Russell Sage laboratory of the Rensselaer Polytechnic Institute by the reduction of the titanifluorides of the alkali metals. Sodium titanifluoride was first prepared by dissolving titanium dioxide free from iron in hydrofluoric acid. This was then almost neutralized with sodium hydroxide when sodium titanifluoride was thrown out as a crystalline precipitate. This compound was then placed in a cylinder fitted with a lid loosely screwed on. The whole was heated and dry alcohol added to take out the excess of potassium. The reduction gives a material containing 68.0% titanium. By reducing titanium tetrachloride with sodium, a product containing 94.73% of titanium was obtained by Nelson and Peterson. Repeating their experiment it gave a yield slightly higher than this. The metal obtained does not differ in outward appearance from polished steel but when cold is brittle and hard. At a low red heat it may be readily forged like red hot iron. Unsuccessful attempts were made to draw the material. The pure metal can be melted only with difficulty. A rod burned in air at 1200° when a current of 50 amperes was sent through a rod of the metal 12 cm. long and 1.8 mm. in diameter. Further experiment determined the melting point to be between 1800° and 1850°.

—*The Sibley Journal*, November 1911



The nation has committed itself to accelerate greatly the development of space science and technology, accepting as a national goal, the achievement of manned lunar landing and return before the end of the decade. This space program will require spending many billions of dollars during the next ten years.

NASA directs and implements the nation's research and development efforts in the exploration of space. The accelerated national space program calls for the greatest single technological effort our country has thus far undertaken. Manned space flight is the most challenging assignment ever given to mankind.

NASA has urgent need for large numbers of scientists and engineers in the fields of aerospace technology who hold degrees in physical science, engineering, or other appropriate fields.

NASA career opportunities are as unlimited as the scope of our organization. You can be sure to play an important role in the United States' space effort when you join NASA.

NASA positions are available for those with degrees or experience in appropriate fields for work in one of the following areas: Fluid and Flight Mechanics; Materials and Structures; Propulsion and Power; Data Systems; Flight Systems; Measurement and Instrumentation Systems; Experimental Facilities and Equipment; Space Sciences; Life Sciences; Project Management.

NASA invites you to address your inquiry to the Personnel Director of any of the following NASA Centers: NASA Space Task Group, Hampton, Virginia; NASA Goddard Space Flight Center, Greenbelt, Maryland; NASA Marshall Space Flight Center, Huntsville, Alabama; NASA Ames Research Center, Mountain View, California; NASA Flight Research Center, Edwards, California; NASA Langley Research Center, Hampton, Virginia; NASA Wallops Station, Wallops Island, Virginia; NASA Lewis Research Center, Cleveland, Ohio.

Positions are filled in accordance with Aero-Space Technology Announcement 252B.

All qualified applicants will receive consideration for employment without regard to race, creed or color, or national origin.

NEWS BRIEFS

Edited by Robert A. Stern, EE '63

Have you ever wished you could get a drink of really cold water right out of the faucet when you're thirsty instead of having to break out a tray of ice cubes and "manufacture" your own cold drink?

If you have, an ingenious manufacturer has the answer for you. He's designed an automatic water cooler small enough to fit under the kitchen sink. It works on the same principle as your refrigerator and uses the same "Freon" refrigerant as the cooling agent.

The cooler hooks into your cold water line and has its own push-down spigot, which can be placed alongside the cold water faucet on the drainboard. It simply refrigerates your tap water down to about 40 degrees and keeps it there ready for you to draw off whenever your thirst needs quenching.

The Army has developed a handy new gadget that will make enough fresh water to keep survivors of sea disasters from dying of thirst.

The new gadget, called the "sit still," was developed by the Army, and operates using the heat from the sun's rays or from the body of an individual sitting on it.

This "do-it-yourself" gadget consists of a sheaf of five sheets about the size of standard typewriter paper. The five sheets are a black plastic film on top, piece of paper toweling or cloth, then a water repellant screen, a sheet of aluminum foil and a cloth backing for the foil. A sponge to collect the fresh water completes the kit.

The fresh water is made by condensation. The five sheets are dipped in the ocean, excess water is drained and the aluminum foil wiped dry. Reassembled with the plastic film on top, the sheaf is exposed to the heat of the sun, or, if it's a cloudy day or night, by the heat from the survivor's body sitting on it.

The heat penetrates to the aluminum foil which is then cooled by the bottom salt-water soaked cloth. In the cooling process, a condensation of fresh water forms on the foil. The survivor uses the sponge to soak up the water, which may be only a few drops, but enough to keep him alive. The efficiency can be increased by using additional sheets of toweling, screen and foil. With additional sets of sheets, a survivor can obtain about a pint of water in 16 hours.

Newest wrinkle in consumer electronics is an instrument that quietly broadcasts a mother's heart throb to comfort a baby when its real mother is out of the room.

Russian chemists are making a concrete construction material from cottonwaste products. The Russians claim the material is three to seven times stronger than cement-based concretes and is fire, water and acid proof. In addition, they say the material insulates against heat and electricity.

A distillery in Scotland employs a dozen and a half geese as security guard around its Glasgow plant. When an intruder appears, the geese quack into action, summoning human guards to make the arrest.

Recent purchases in the oil-rich Arab state of Kuwait have given it the world lead in number of air conditioners per capita. Kuwait now has one conditioner for every 16 inhabitants. The U.S. is second with one for every 23.

Pocket-size lie detectors exported by Japan soon will be on the market. The transistorized battery-powered detectors will measure the change in a person's pulse, breathing and blood pressure caused by the "mental commotion" of telling a lie.

Scientists estimate that during one year, the energy equivalent of about two billion nuclear bombs (each of 20,000 tons of TNT) moves across latitude 40° in winds. They calculate that the energy in the winds over the entire globe at any one time is equal to about seven million nuclear bombs.

By mid-1963, about a fifth of the nation's 5,477 radio stations may have automated their broadcasting operations. For about $6,000, stations can buy equipment that permits them to tape and then air 18 hours of music, disc jockey chatter and other programs without touching a phonograph record.

Such items as foot powders, tooth powders and talcums soon will appear in aerosol form. The technical problems of packaging the powders under pressure have been solved, and many companies are just awaiting a showing of customer demand.

A Viennese manufacturer has brought out a tape recorder reputed to be the world's smallest. The recorder weighs less than a pound, has three transistors, and measures 4½ x 3¼ inches. It has a five-track recording system, 12 minutes per track, and is designed for one-hand operation.

A dentifrice that requires no brushing and is in tablet form is due to appear on the market. The single-use foaming tablet is simply swirled about in the mouth.

Dry ice is being used to keep coal cool enough to prevent spontaneous combustion. Pipes perforated and filled with dry ice are hammered into piles of coal. This not only decreases the temperature, but also spreads a blanket of carbon dioxide which smothers a fire.

Midwestern research workers are trying to build an electronic nose that would detect smells according to changes in the electrical potentials on its surface. The nose could be used in studying food aromas, food spoilage, industrial or military warning systems and even for finding out if there are smells in space.

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